NOAA's National Weather Service

Advanced Concepts of

Severe Storm Spotting

2009 – Rusty Kapela

Milwaukee/Sullivan

weather.gov/milwaukee

Spotter Aids:

1. Road Maps - state, county, city
2. NOAA Weather Radio All Hazards
3. Binoculars & compass
4. Camera - video, digital or regular
5. Watch or Clock
6. Cell phone or radio transceiver
7. Report log or audio recorder
8. Spotter ID card
9. Handheld Anemometer

(Spotter under approaching shelf cloud in Franklin Co. IL 4/21/02)

Problems Spotters Encounter

- Spotters can only see a limited area, and much of the time the spotter view is being blocked by rain/hail, hills, trees, and buildings.
- Spotters have a hard time getting the “big picture” of what is going on around them.
- Mobile spotters may not have access to radar data to find where to go.
- Spotters have a hard time judging distances to weather phenomena…underestimate.

Lightning Safety

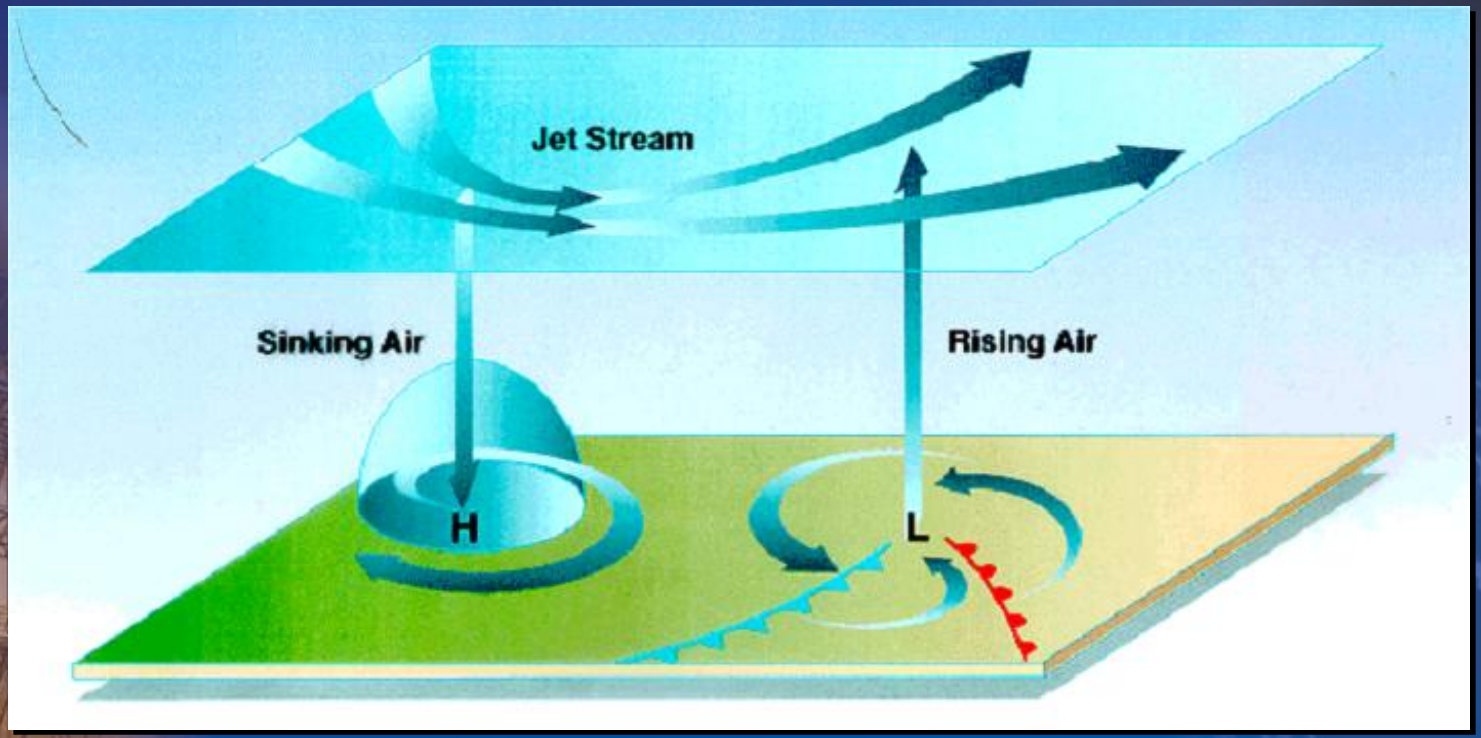
Warnings are not issued for lightning.

If you're close enough to hear the thunder, your close enough to be struck.

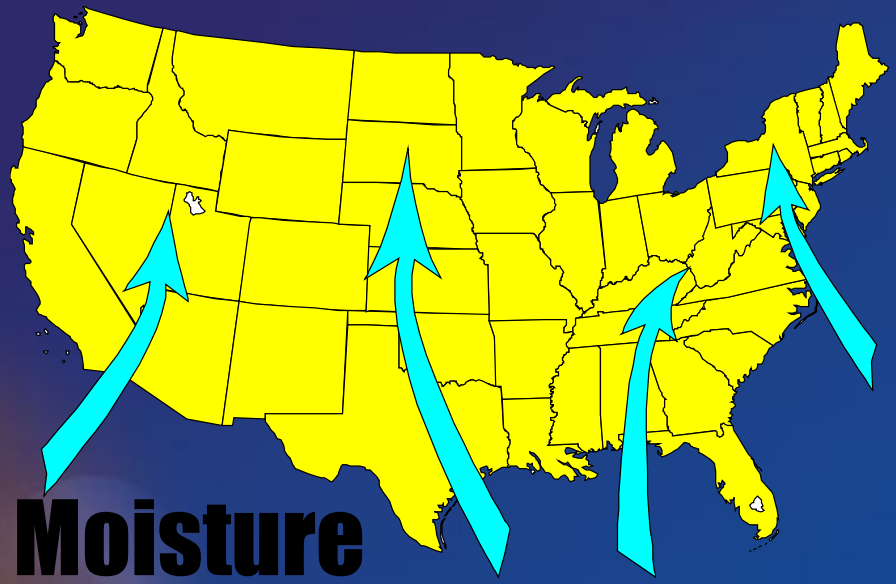
Big Picture & Ingredients

The Big Picture

- Surface Low Pressure Systems are associated with counter-clockwise flow, upward motion, and are typically the "weather makers"
- Surface High Pressure Systems are associated with clockwise flow, downward motion, and typically bring calm, inactive weather

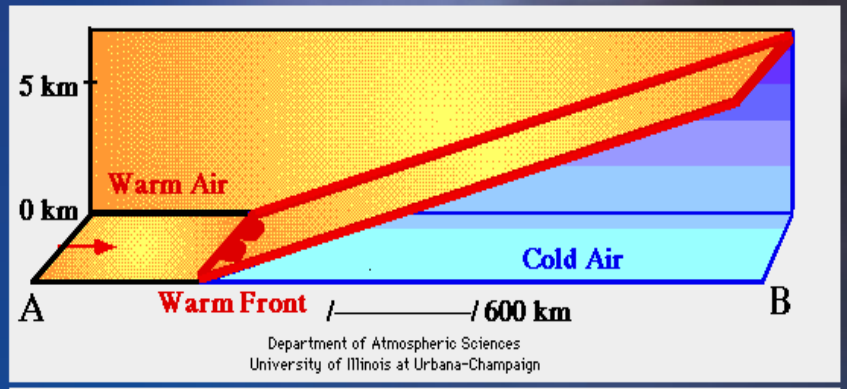


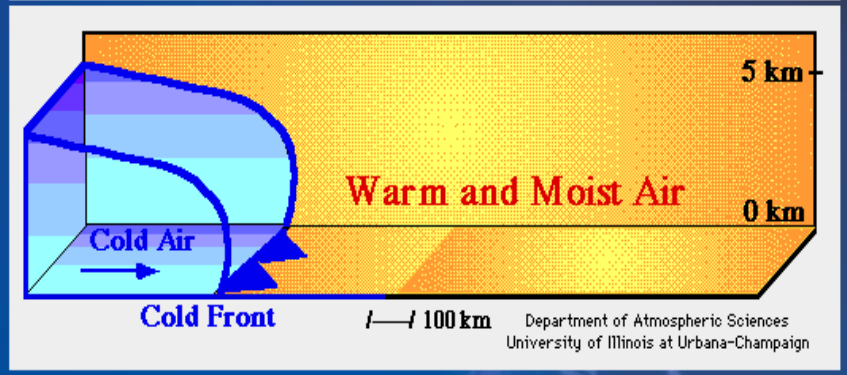
Thunderstorm Ingredients

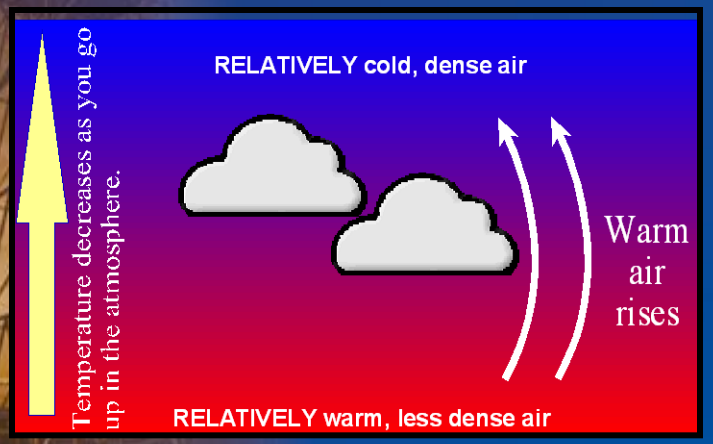


Moisture

Lift

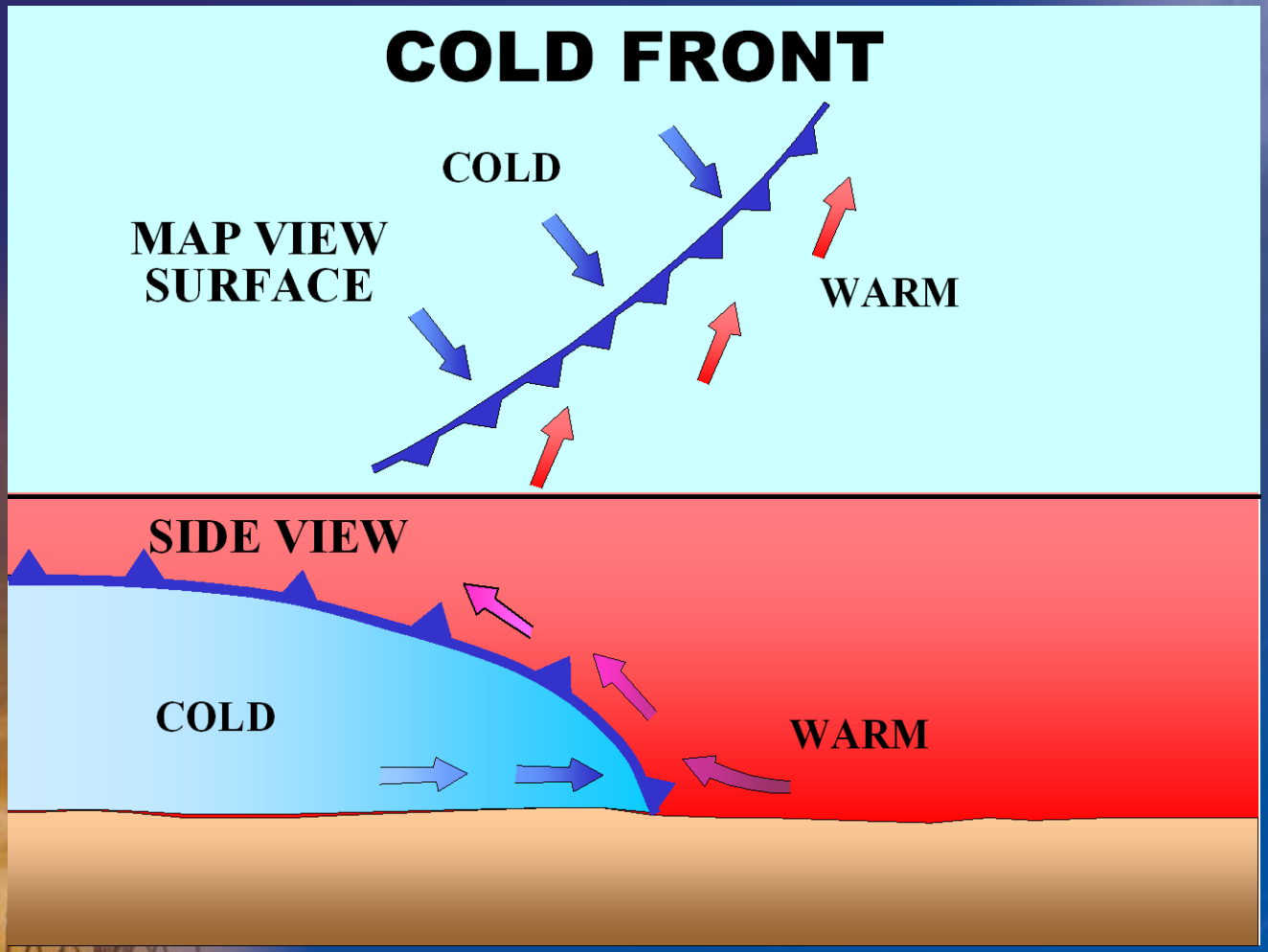






Instability

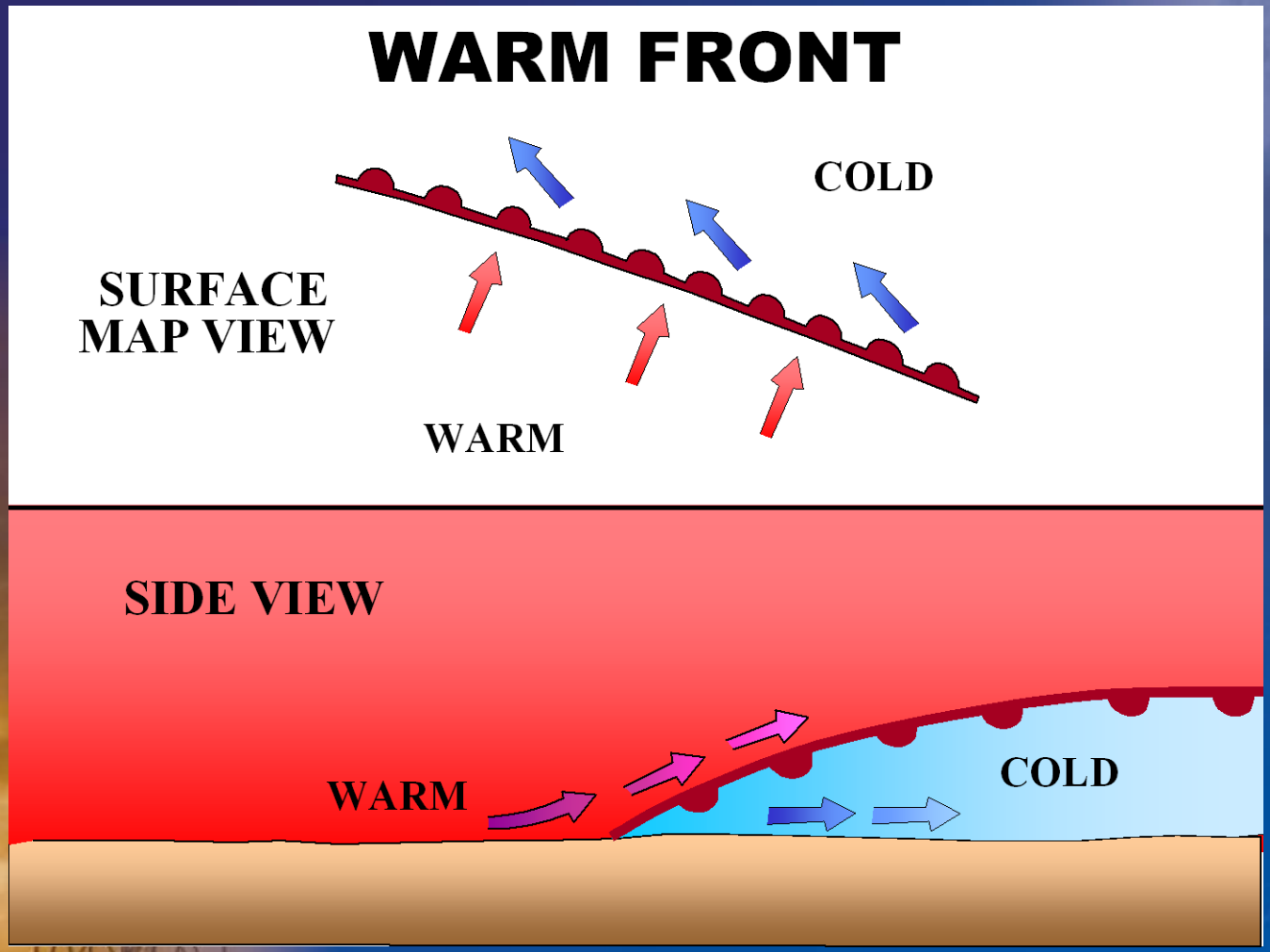
Cold Fronts



Top down view

Side View

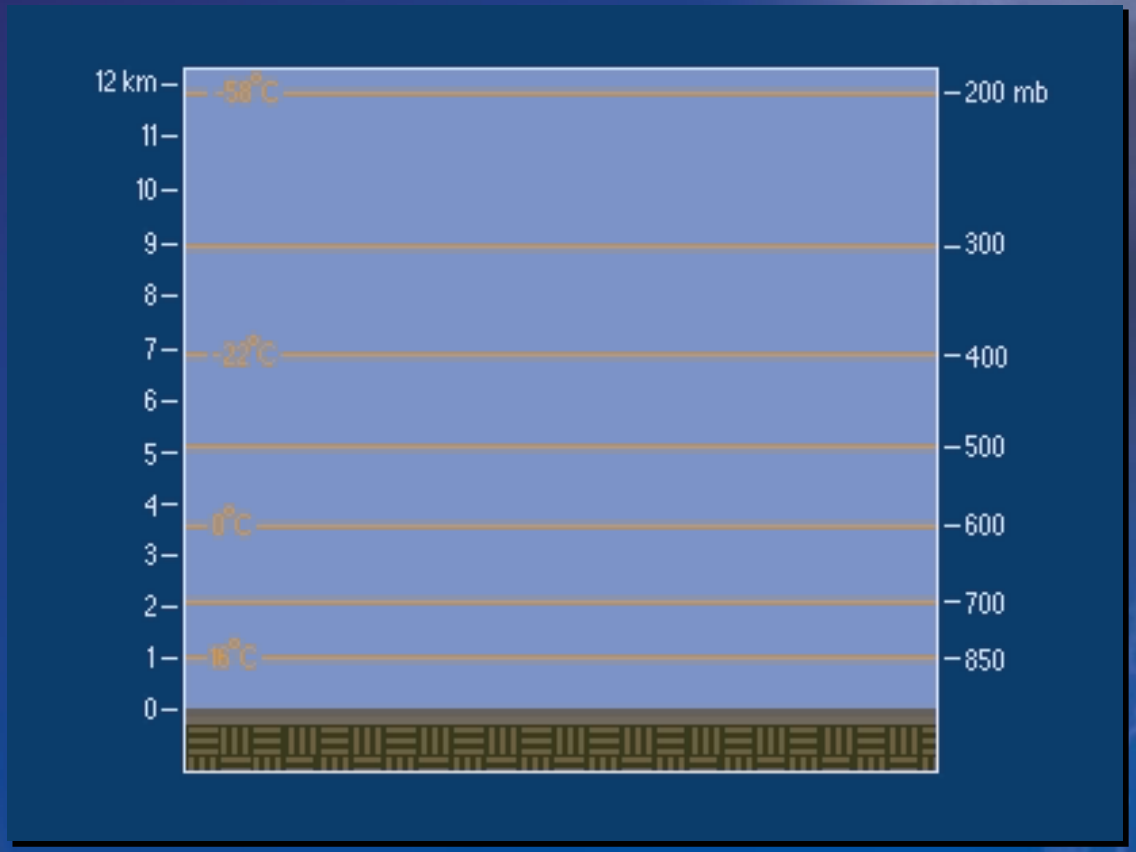
Warm Fronts



Top down view

Side View

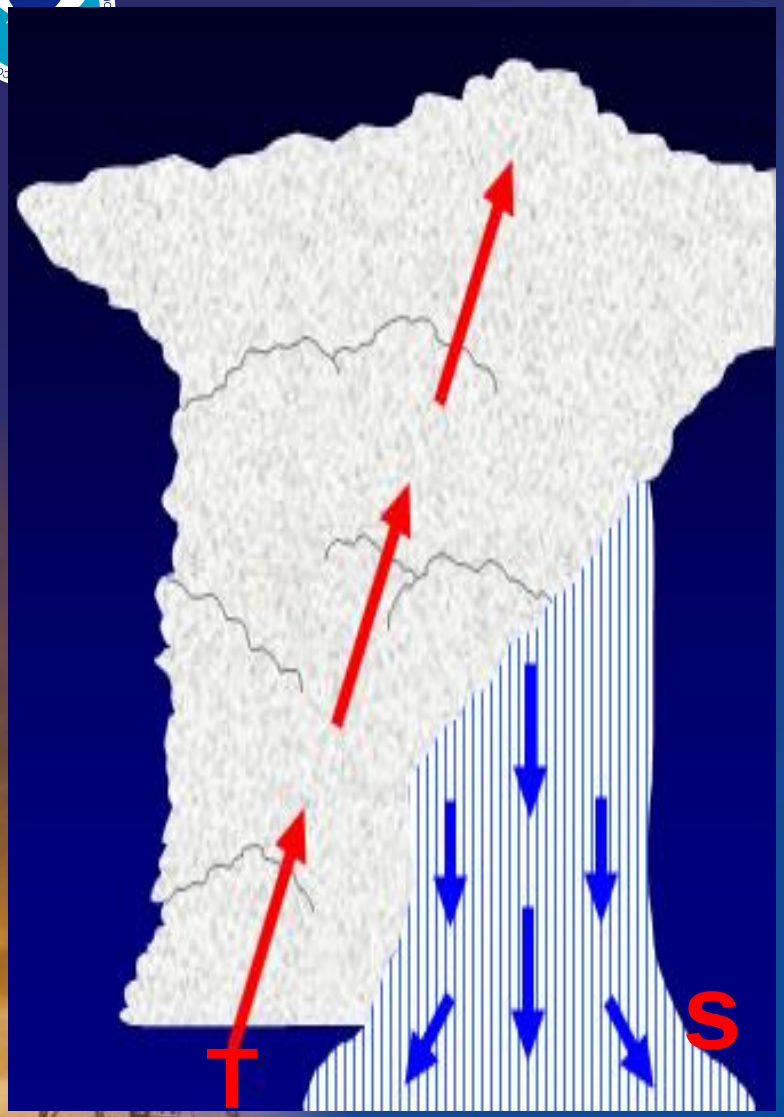
Thunderstorm Structure (Life Cycle)



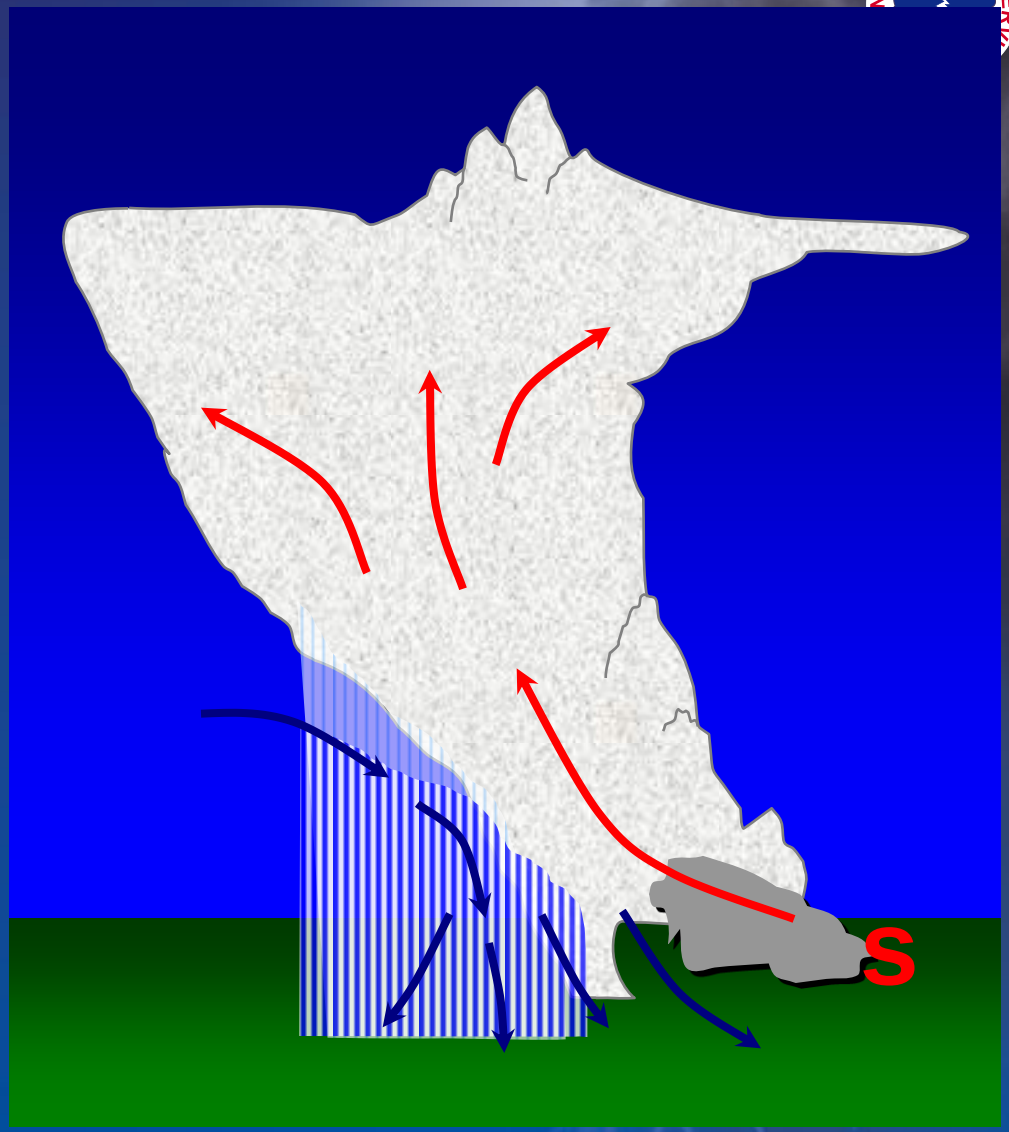
Animation

Tunderstorm!

Storm Motion

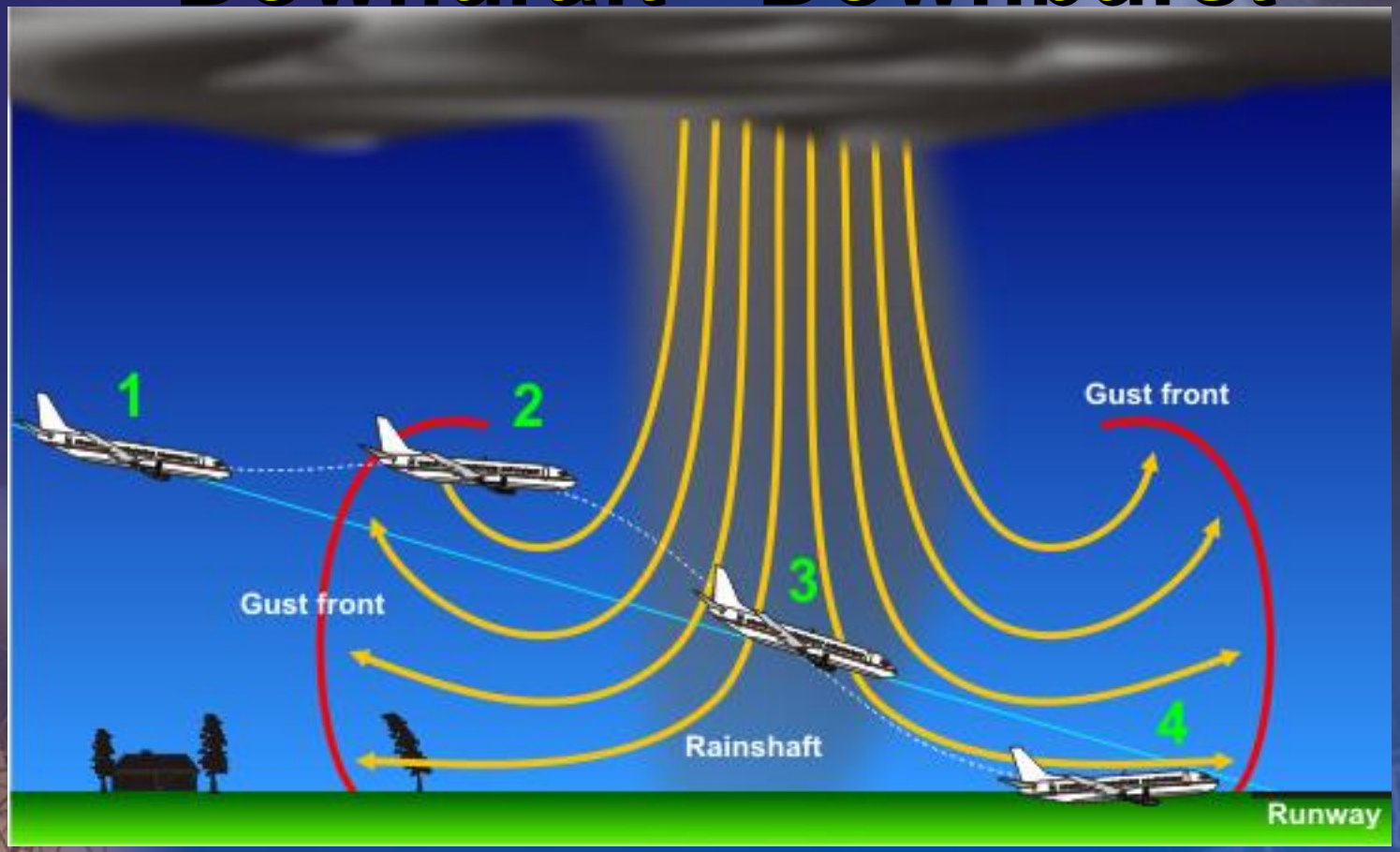


Tornadic Thunderstorm



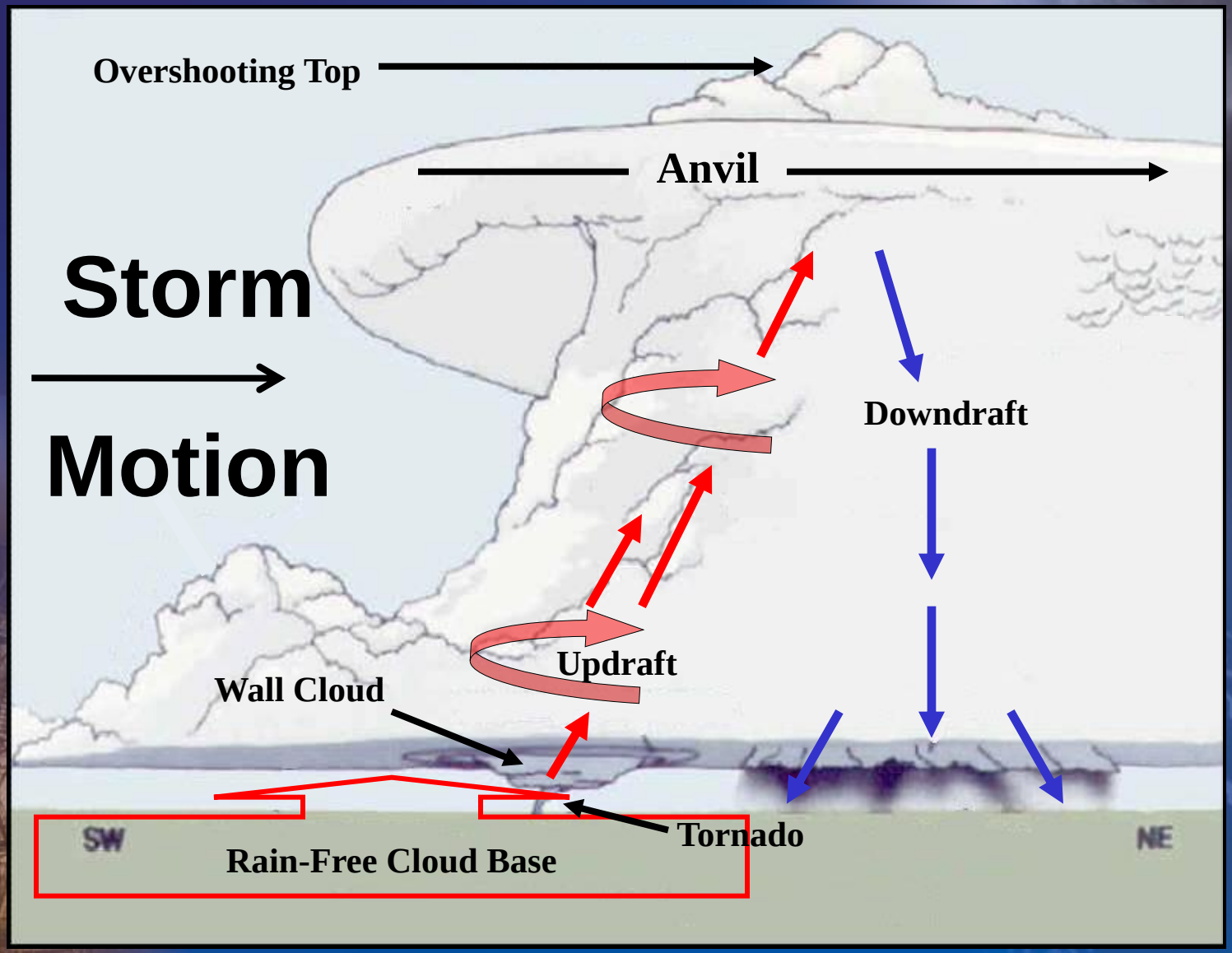
Non - Tornadic Thunderstorm - Squall Line

Downdraft - Downburst

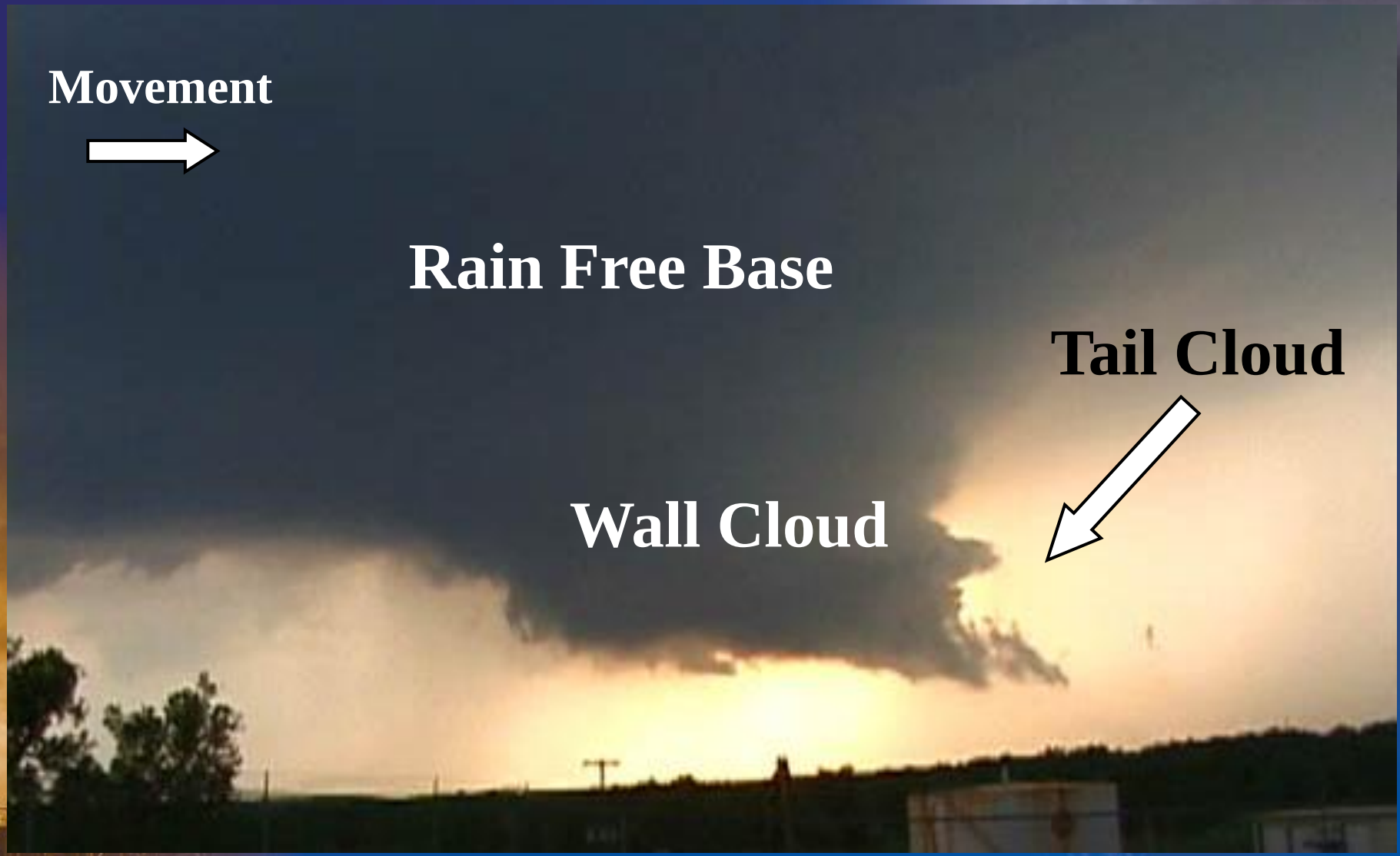


Gust Front - is leading edge of downdraft/ downburst, you don't see it but you do feel it as winds pick up and temperatures drop and then rain/hail.

Tornadic Tstm Structure

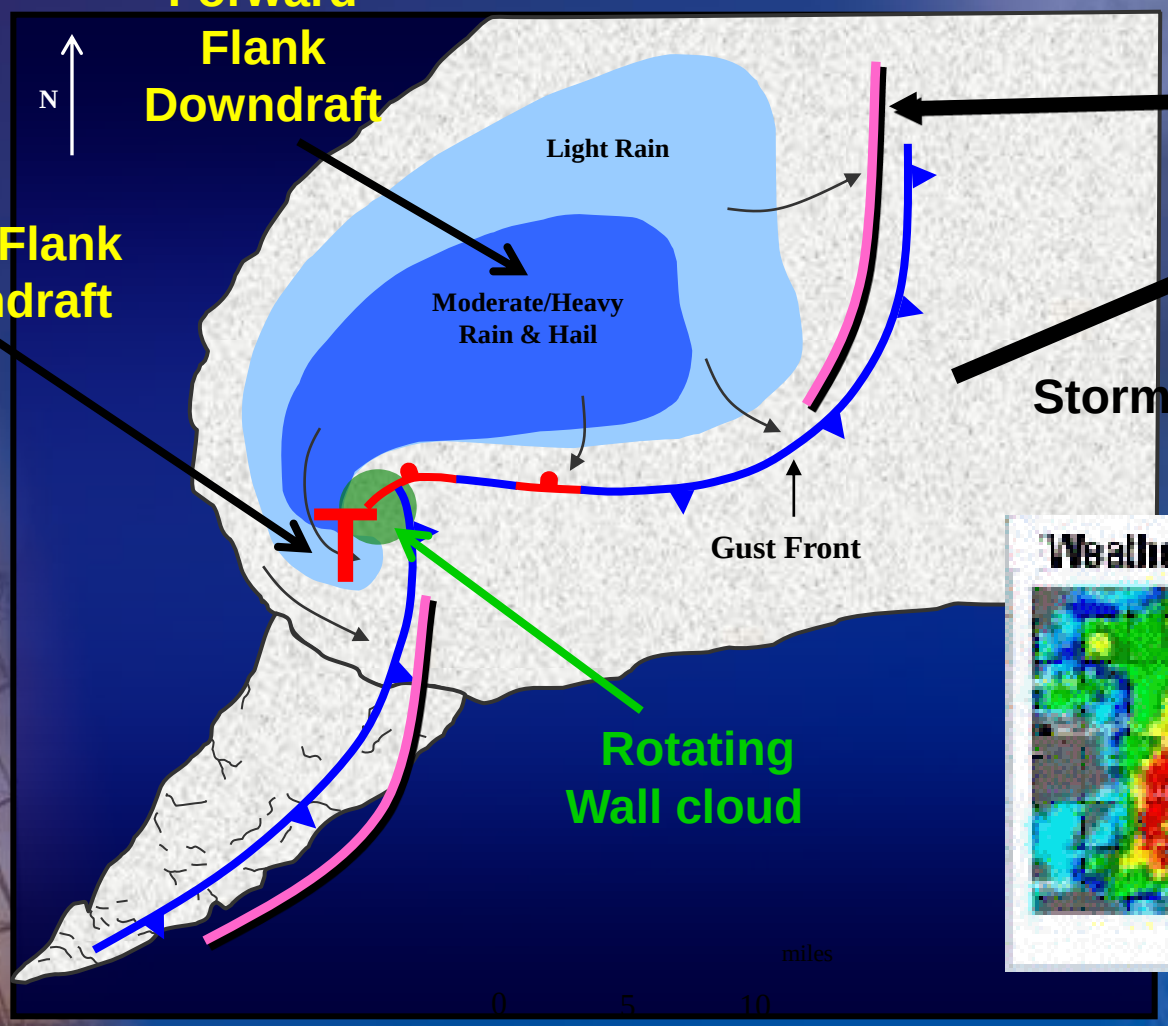


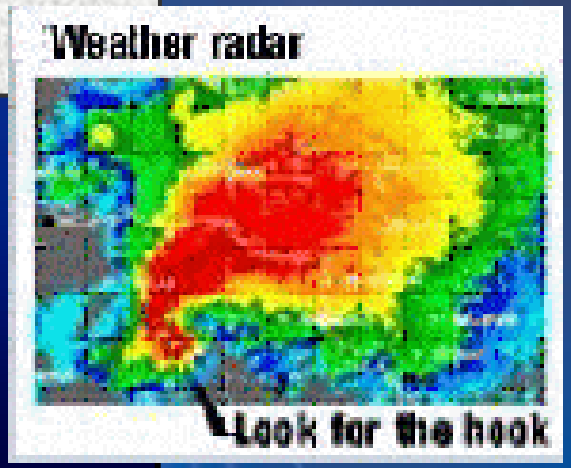
Wall Cloud



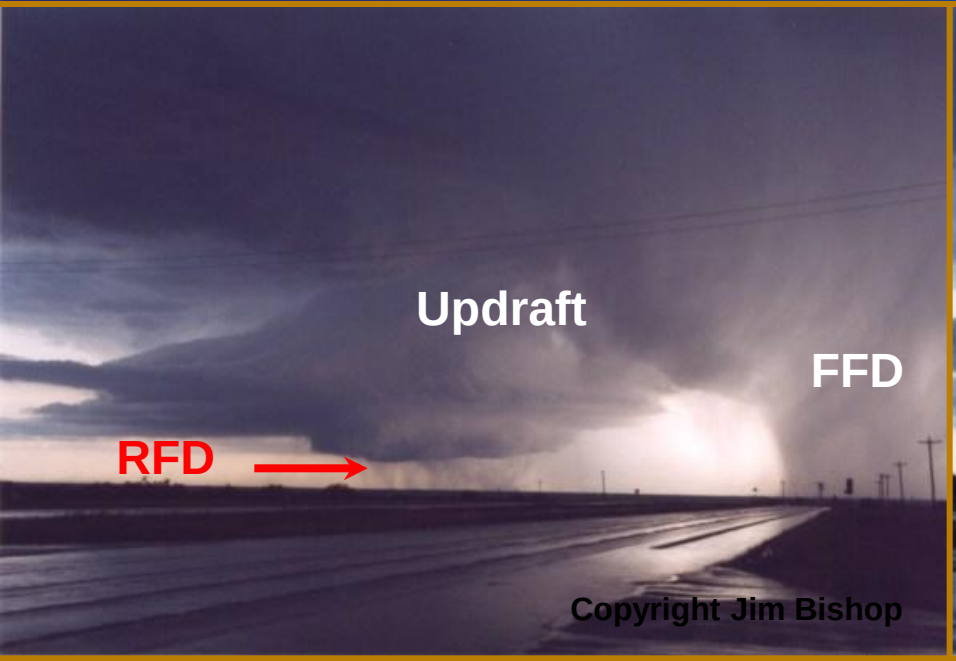
Tornadic Supercell Thunderstorm

top down view

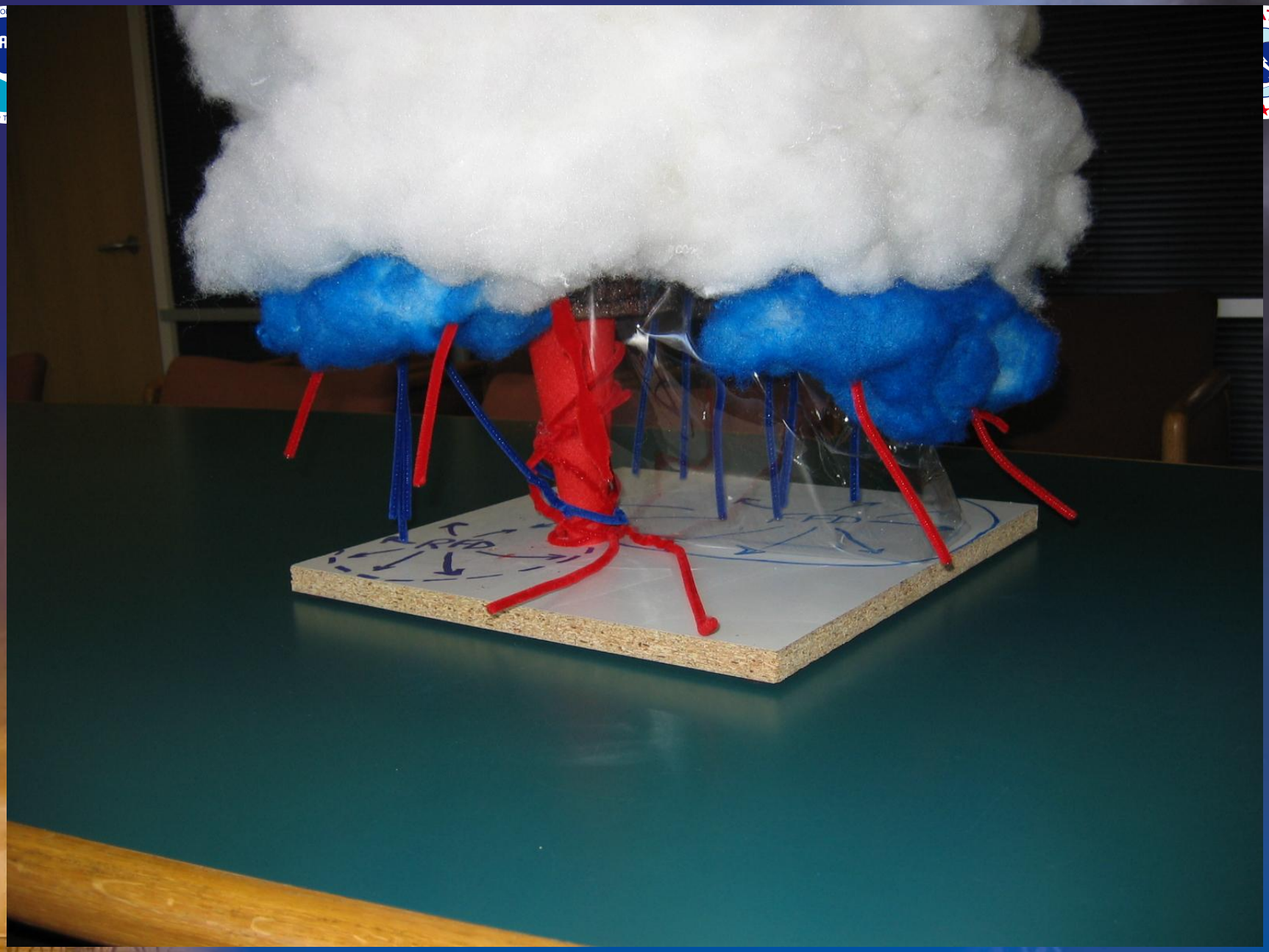




Wall Cloud & FFD & RFD



What a difference a few minutes can make!



Tornado

Near Central City, IA, Apr 26, 2009

What Do You See?

Video

Oakfield, WI - July 18, 1996

- *Reached F5 intensity*
- *30 minute duration*
- *Maximum path width of 400 yards*
- *13.3 mile path length*
- *$40.5 million in damages*
- *12 injuries*

(705-735 pm… people could see it, county fair in progress, and Oakfield police officers and fire fighters recognized early on when they had a tornado and activated their sirens)

Updraft & Downdraft Regions

Updraft & Downdraft Regions

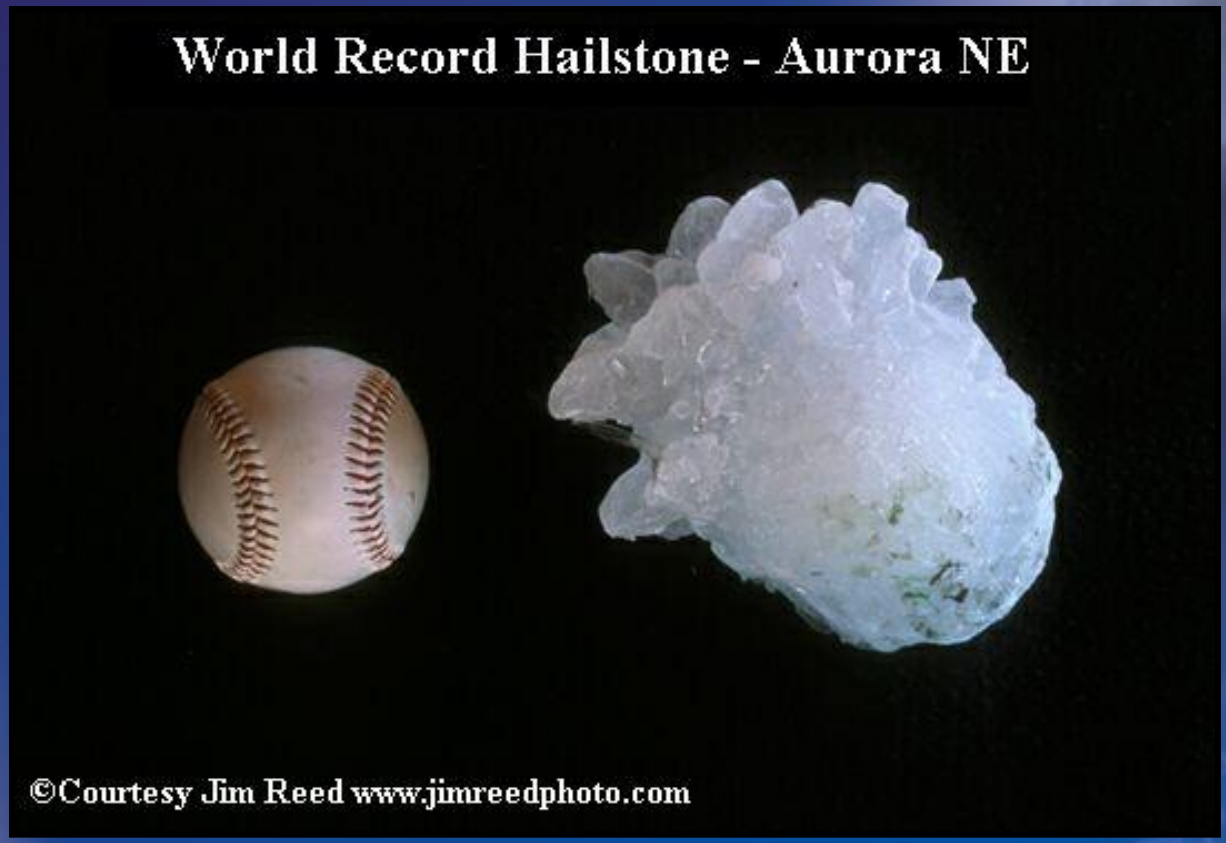
Photo courtesy of www.extremeinstability.com

Updraft & Downdraft Regions

Rain Foot = Strong downburst winds

Hail Shaft

Hail



Aurora, NE - June 22, 2003

6 ¾ inches in diameter

Thunderstorm Types

Types of Thunderstorms

Single Cell	Multicell Cluster	Multicell Line "Squall Line"	Supercell
Weak updraft (non-severe or severe)	Moderate updraft (non-severe or severe)	Moderate updraft (non-severe or severe)	Intense updraft (Always severe) Mesocyclone - Rotating updraft
Slight threat	*Moderate threat*	*Moderate threat*	*High threat*



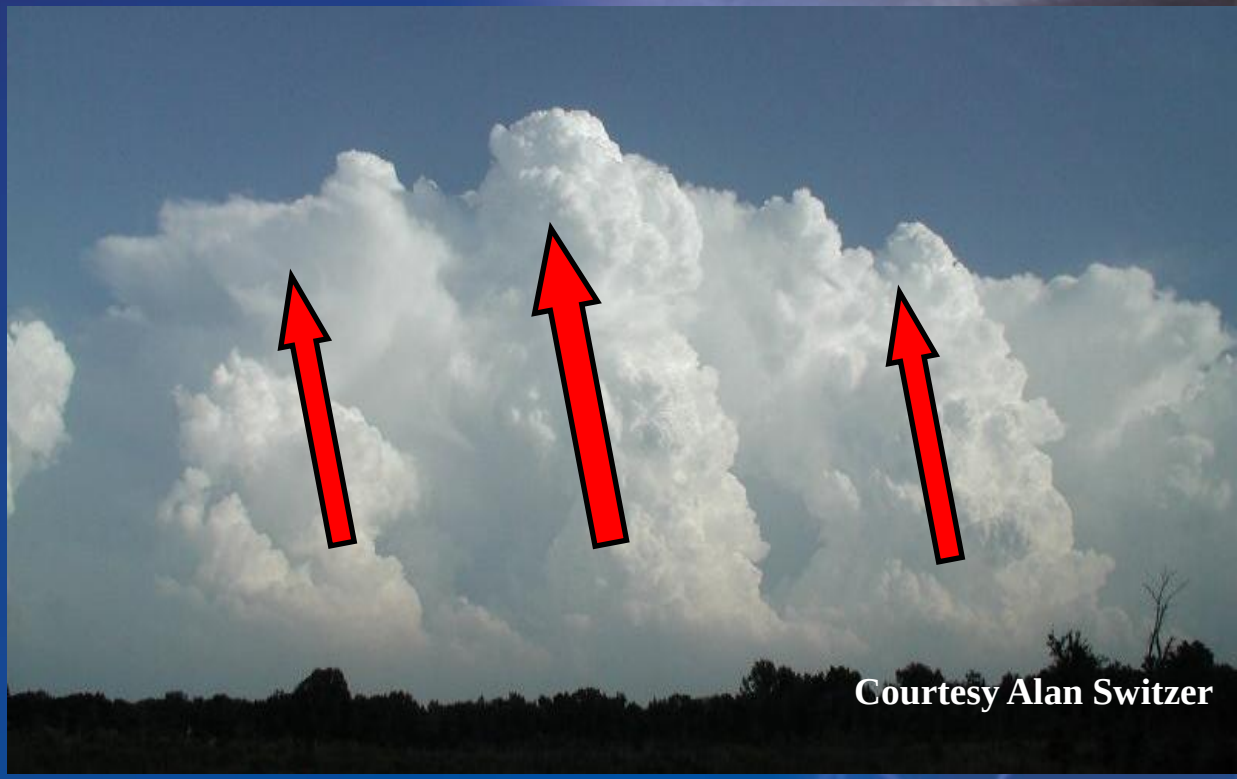

Single Cell Storms

May produce brief severe events

Multi-cell Tstm Clusters

Ordinary non-organized storms with low severe threat

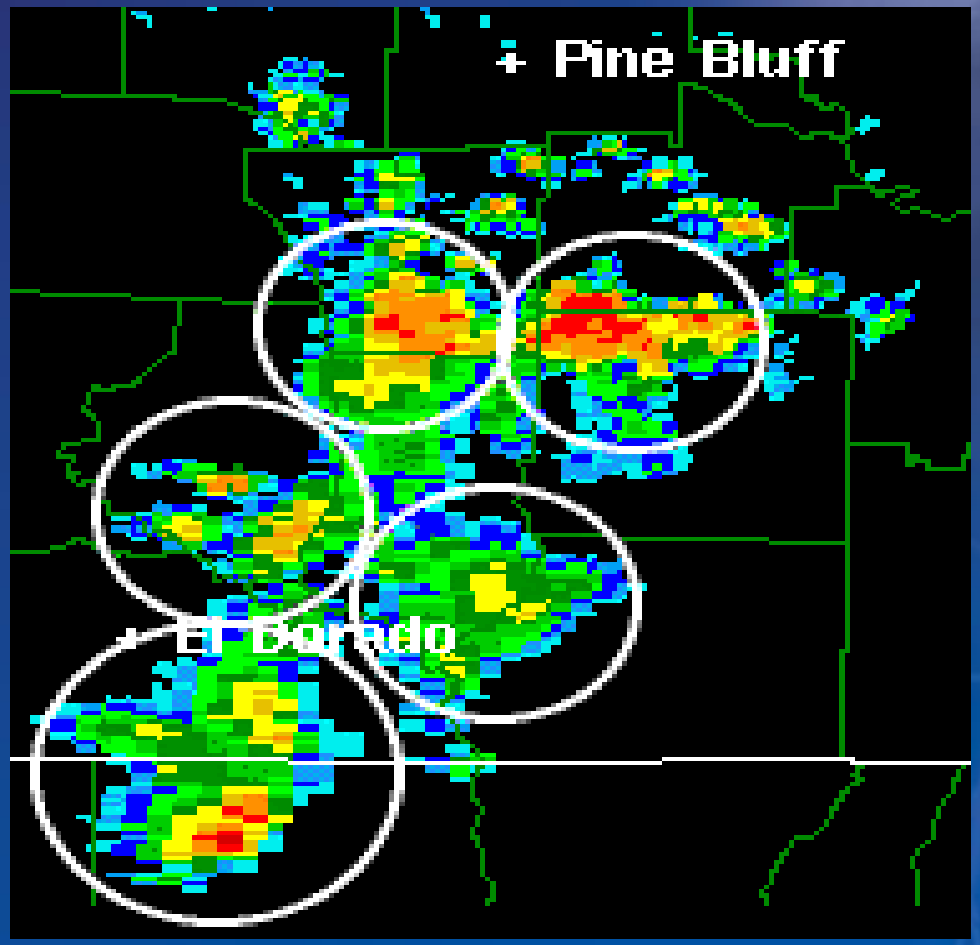
- Each cell lasts about 20 minutes, but a cluster can last for hours.



- Heavy rain is the main problem. However, strong winds, small hail and weak tornadoes are possible.

Multi-cell Thunderstorms

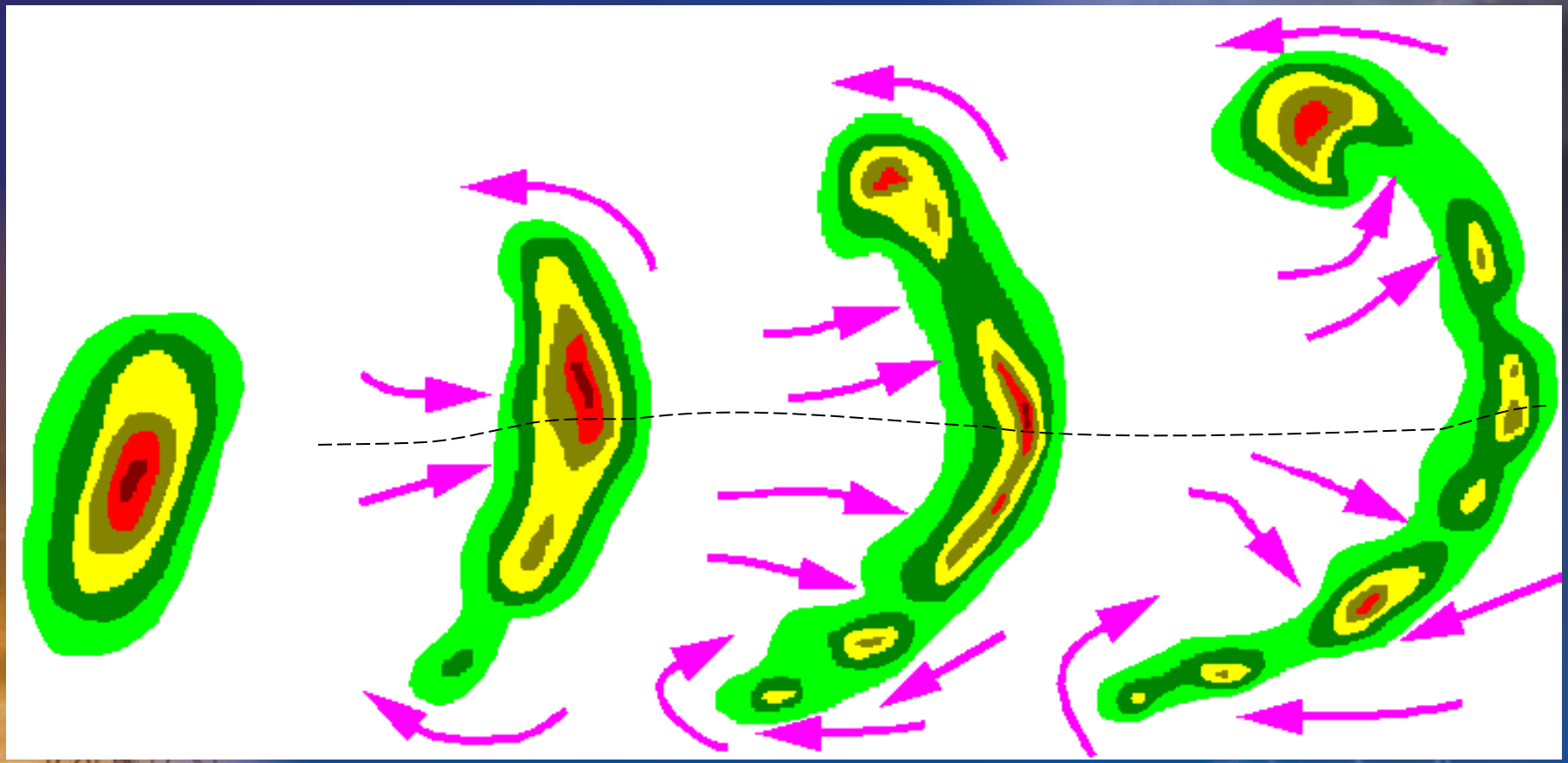
Ordinary non-organized storms with low severe threat



Multi-cell (Squall) Line

- Leading edge of Squall Line.
- What to expect
  - *Strong and possibly damaging wind*
- Heavy rain/hail

Multi-cell Line (Bow Echo)

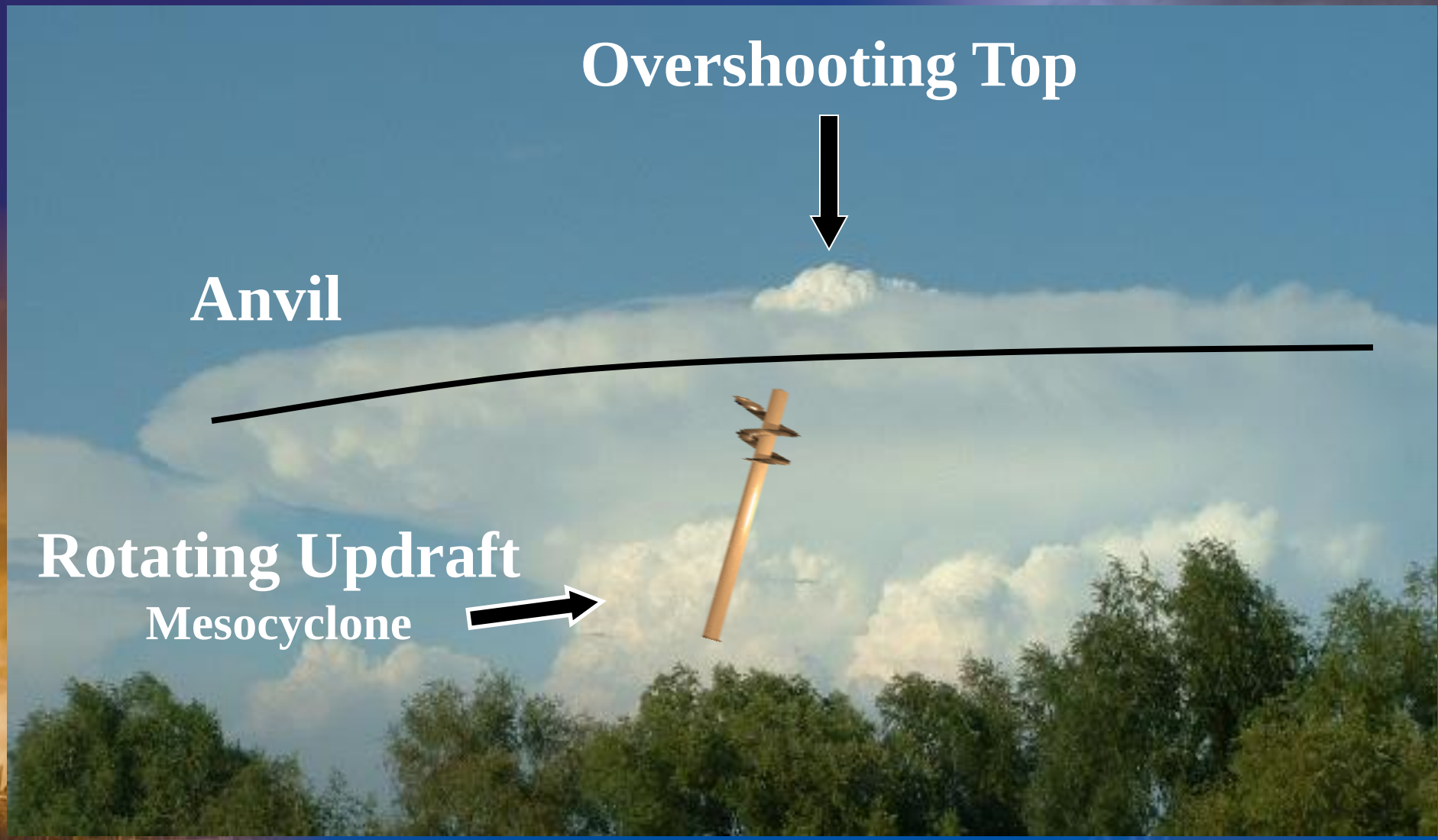


Supercell Thunderstorm

- Contains a rotating updraft called a mesocyclone
- Produce large hail, high winds, and strong to violent tornadoes
- Lasts for several hours

Supercell

Main Features



Supercell Thunderstorm

3 Types of Supercells

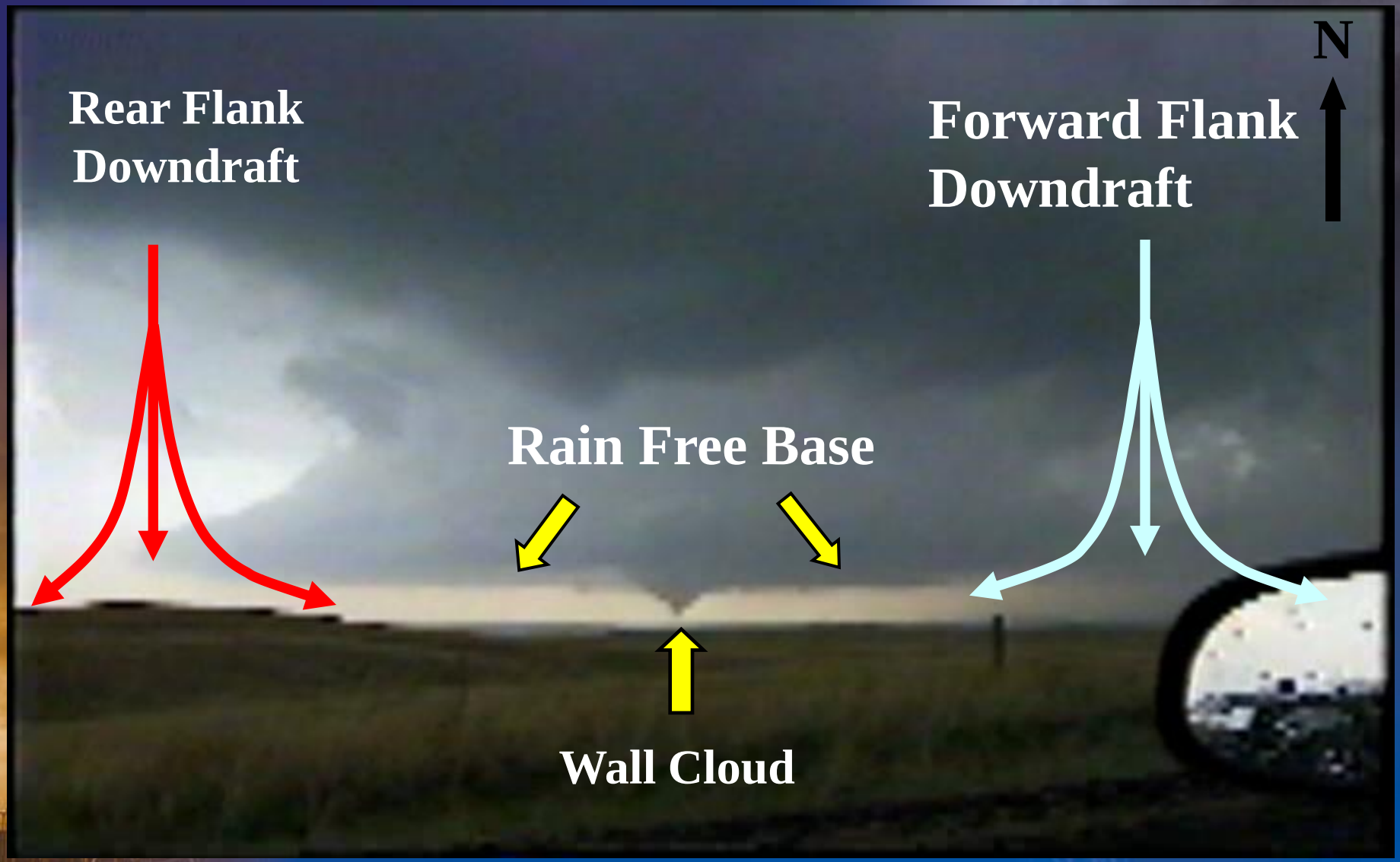
Classic

High Precipitation

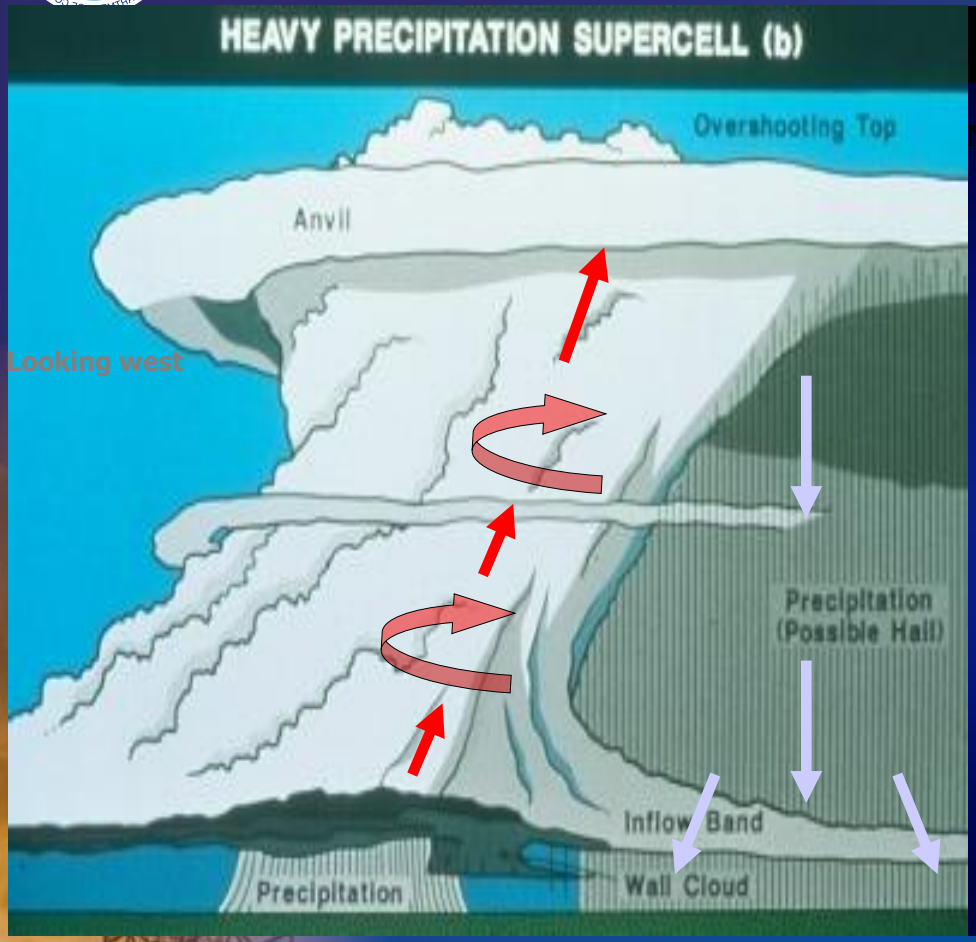
Low Precipitation

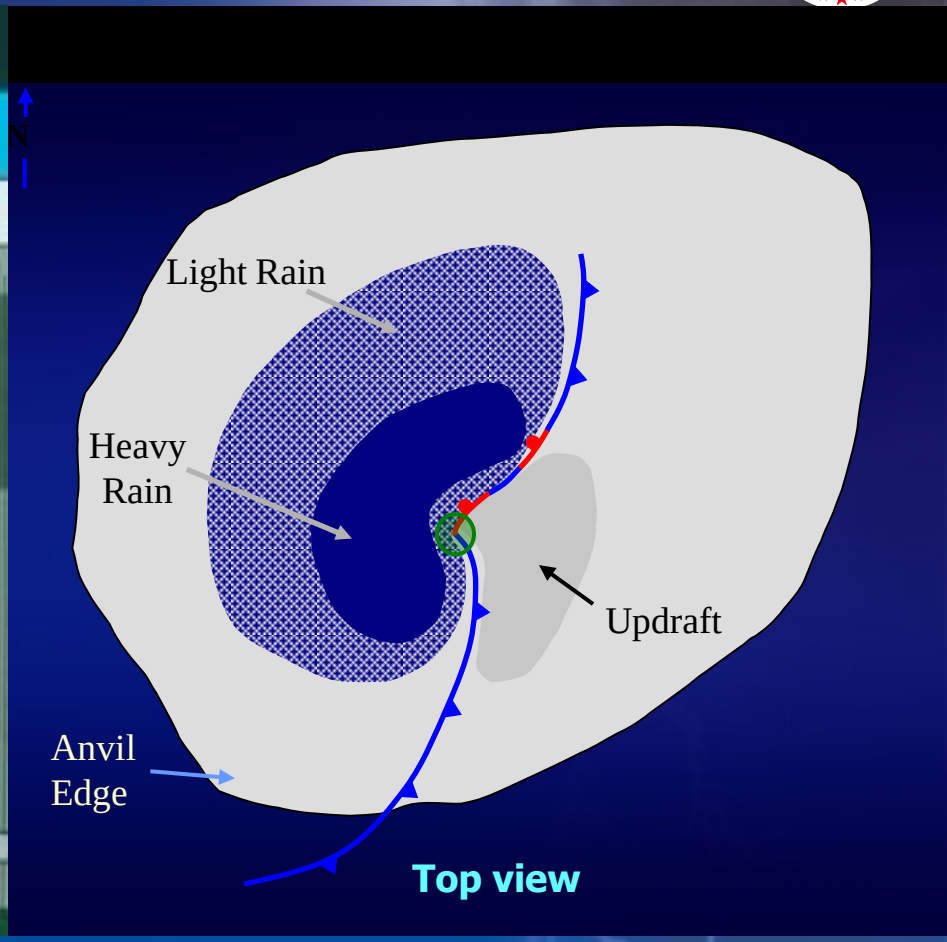
Supercell

Main Features



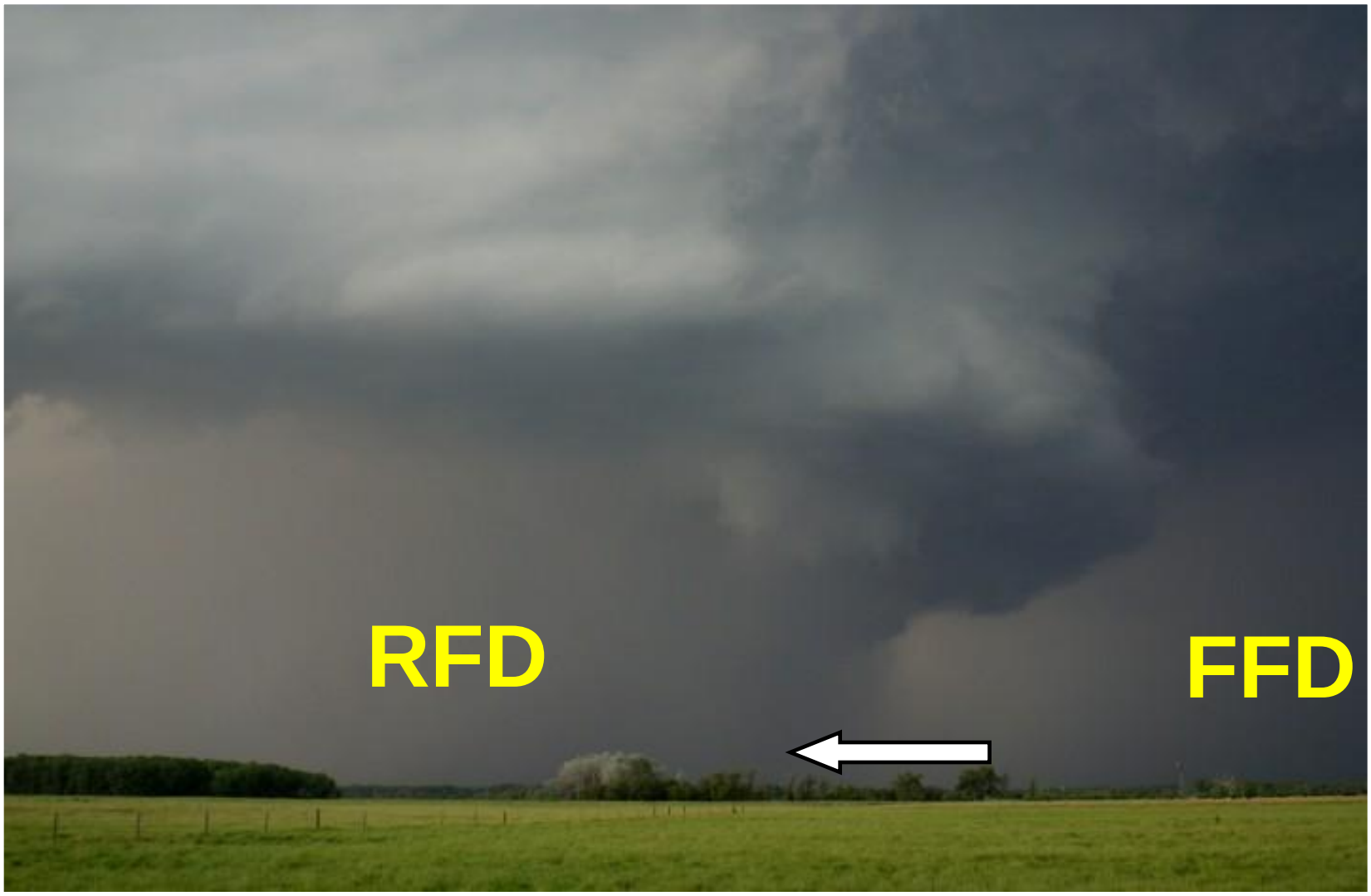
HP Supercell





Generally, there is not a good spot to view this type of storm since it is wrapped by a rain shield.

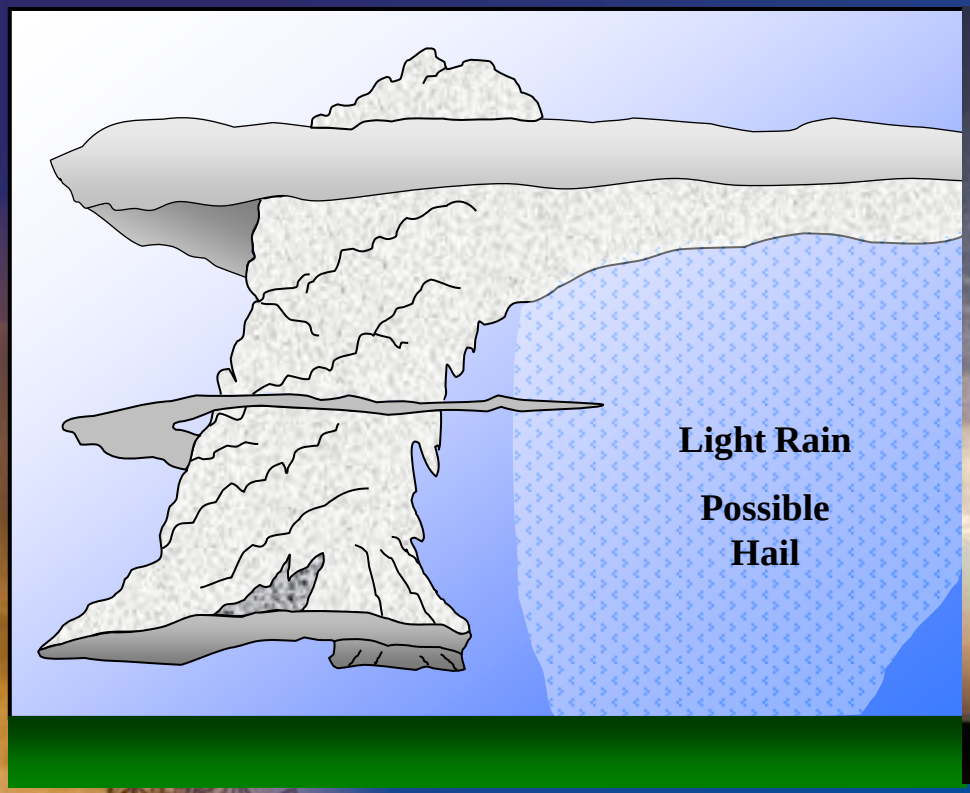
HP Supercell



HP Supercell

HP supercell (Hidden Tornado)

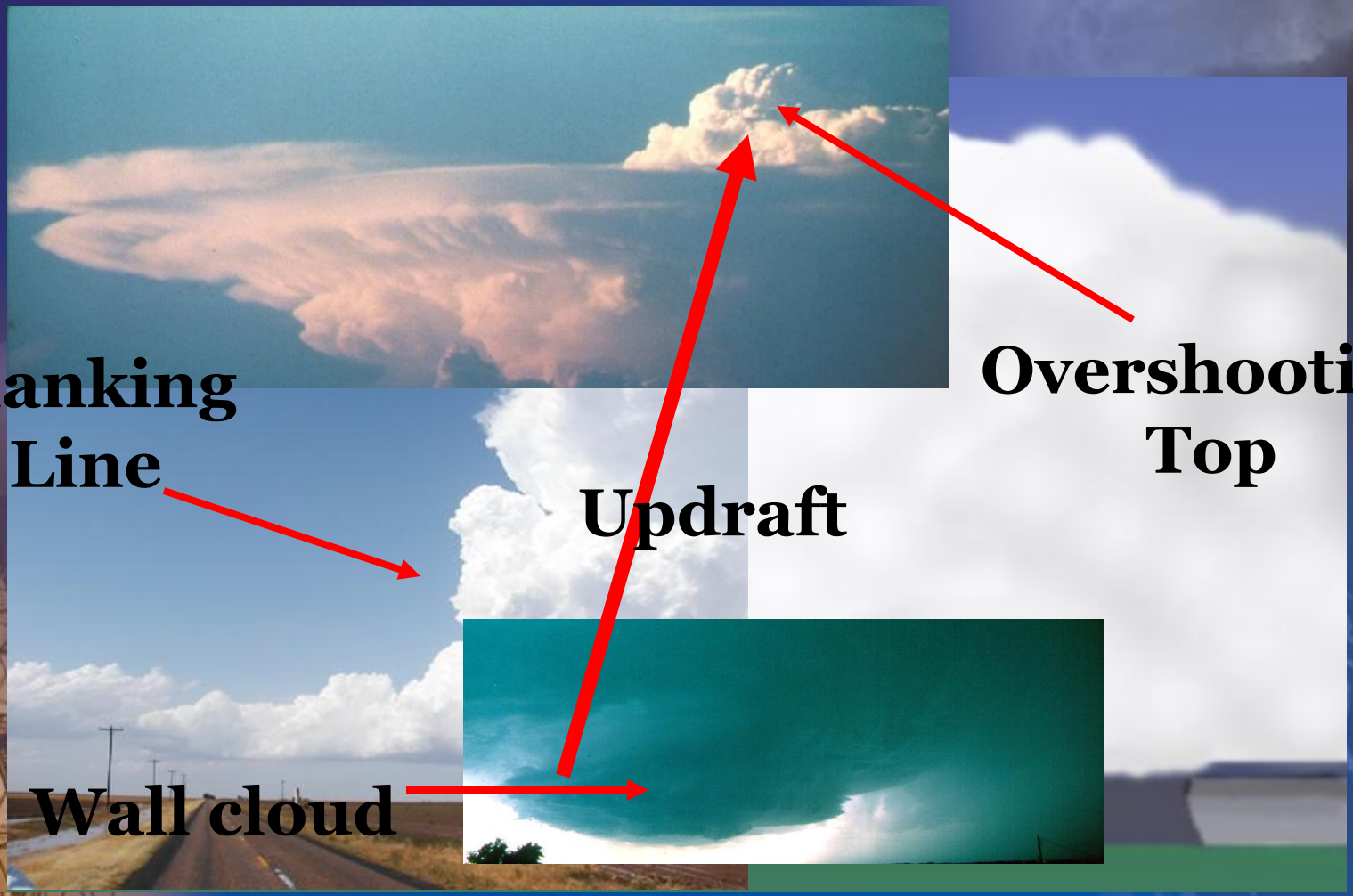
LP Supercell



LP Supercell

Storm Intensity Clues

Storm Strength Clues



Evaluating the Surroundings

A thick, crisp anvil is another sign of a strong updraft

An indication of a rapidly, intensifying storm!

Low Level Storm Clues

- Low, flat cloud base with little visible precipitation falling.
- On the back side of a potentially tornadic storm.

Understanding

Rotation

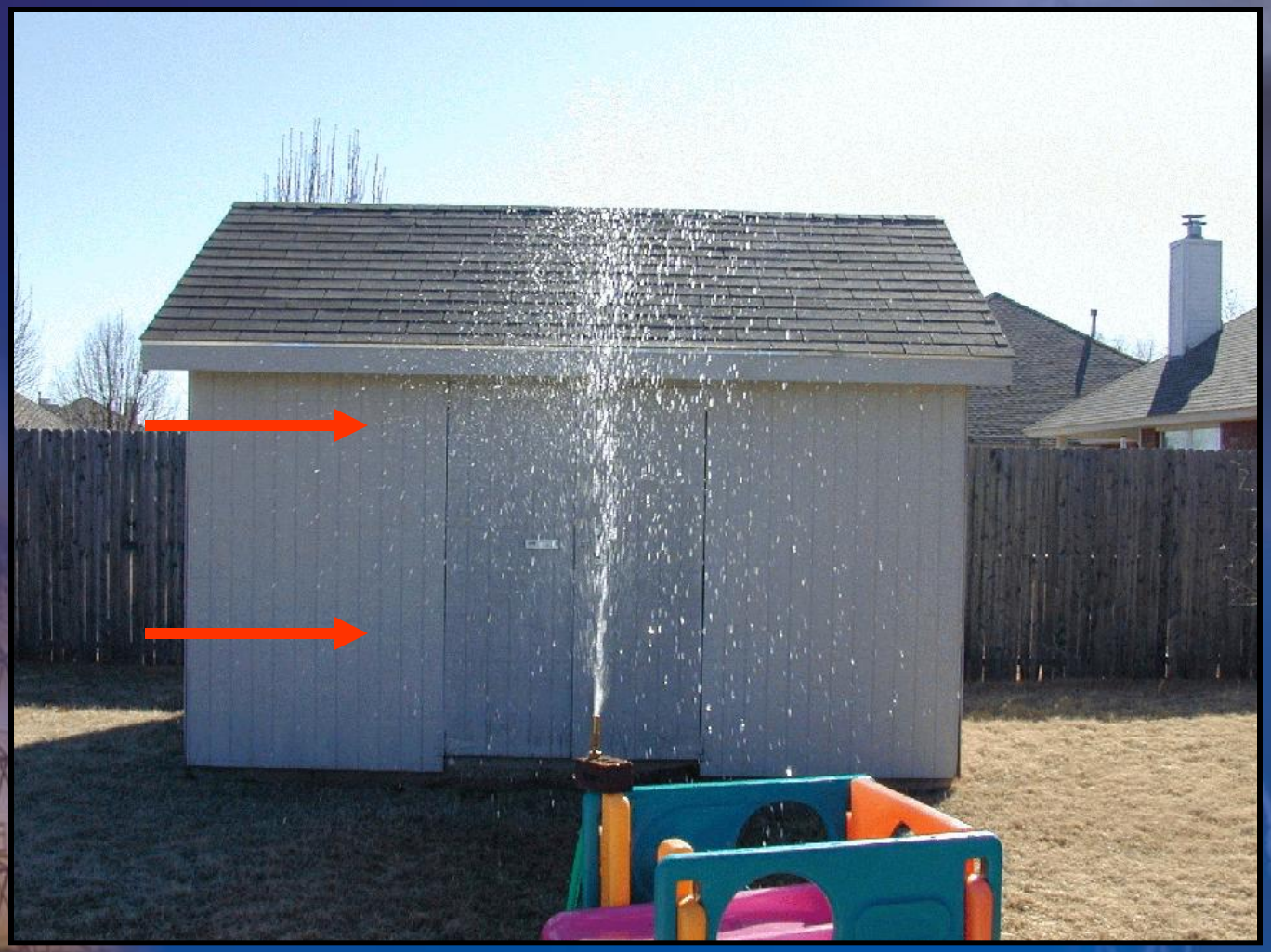
Understanding Rotation

- In order to generate a tornado, a storm needs two basic things

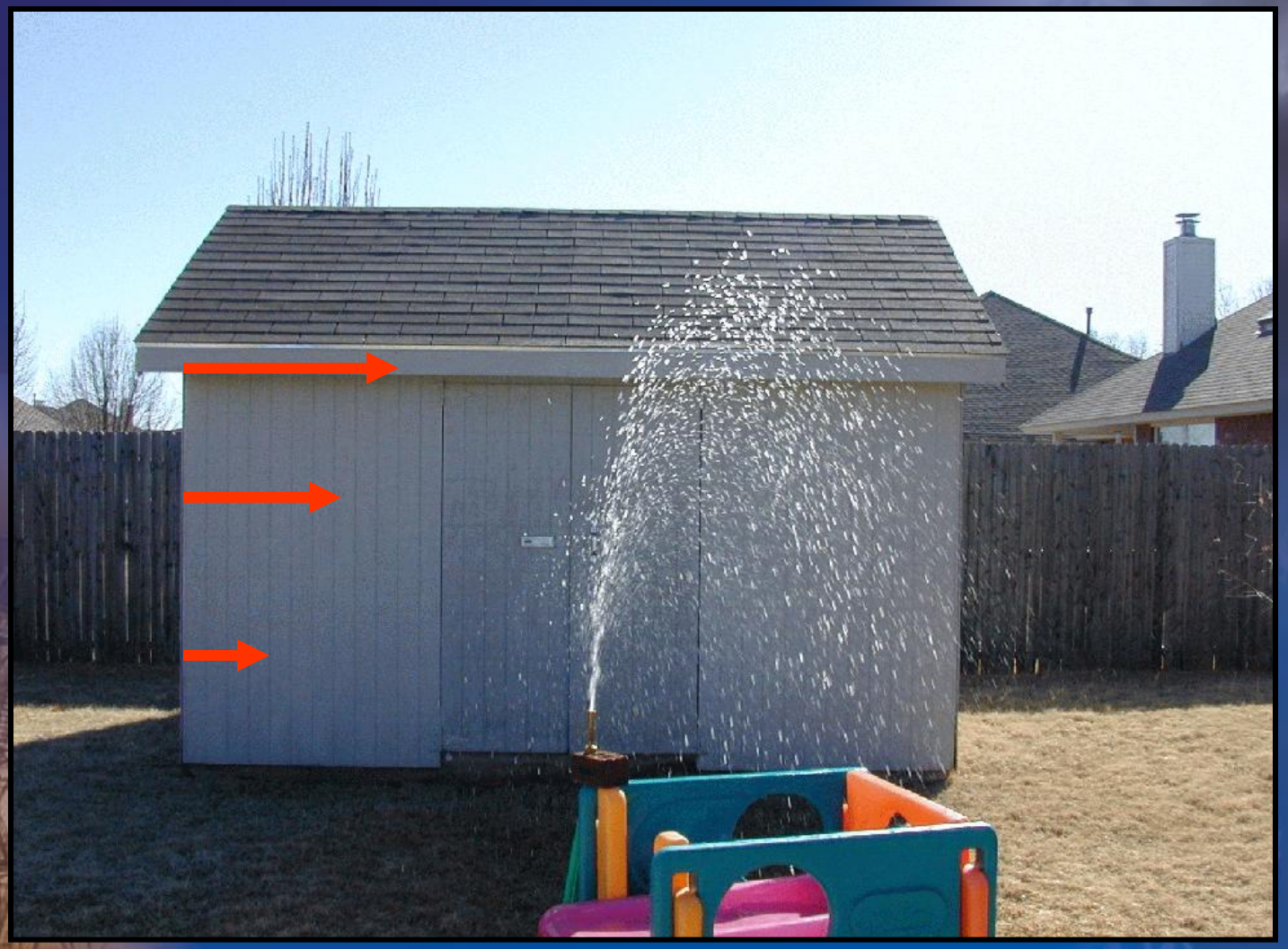
  1. Time – it must persist for an appreciable time (long-lived updraft that doesn't get choked by downdraft).

  2. Wind shear that translates into vertical rotation.

Updraft
Weak Wind Speed Shear



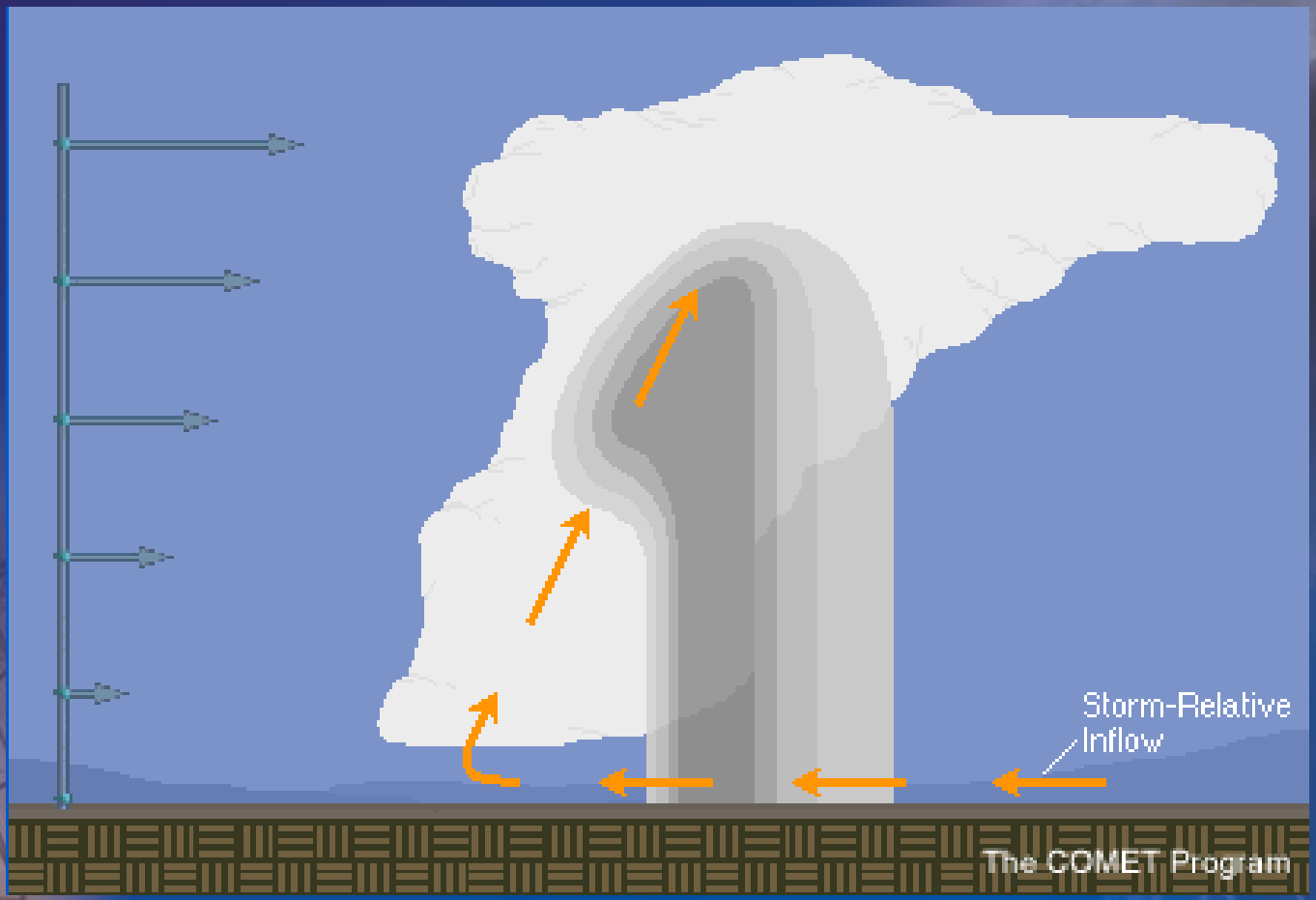
Updraft
Strong Wind Speed Shear



Shear

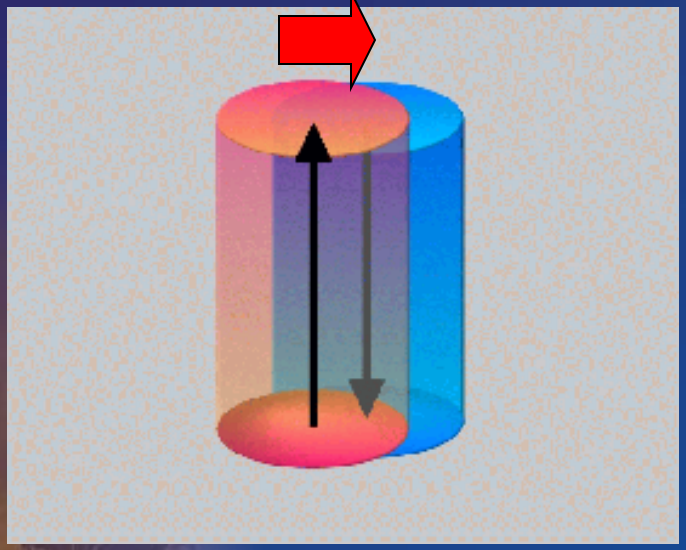
Note the tilted storm tower…vertical wind shear… downdraft rain is shifted downstream

Updraft Lean



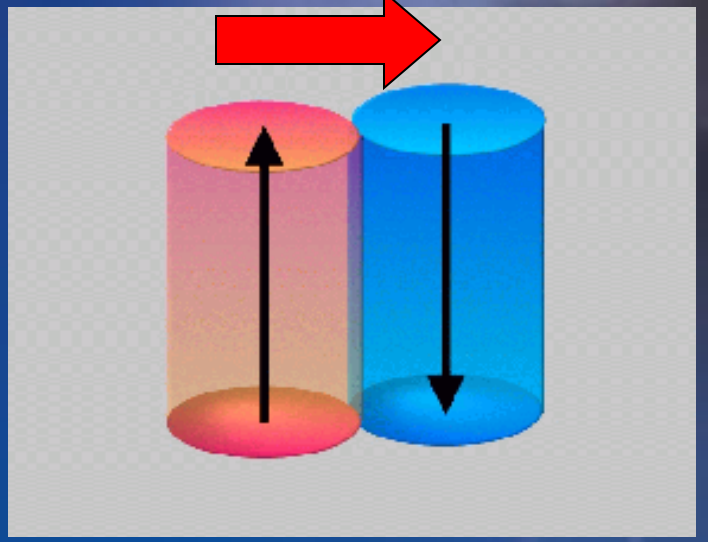
Vertical Wind Shear

Weak



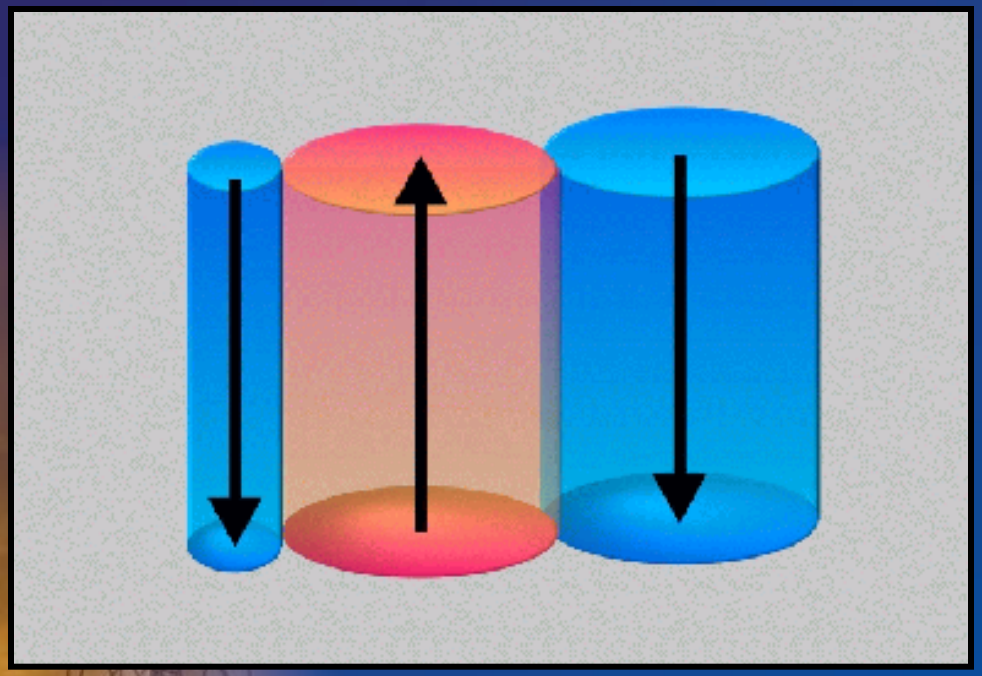
- Very little separation between updraft and downdraft. Downdraft chokes updraft causing storm be short-lived.

Strong



- Tilted Updraft & downdraft are separated, so they co-exist. Therefore, the storm lives longer.

Supercell Structure/RFD

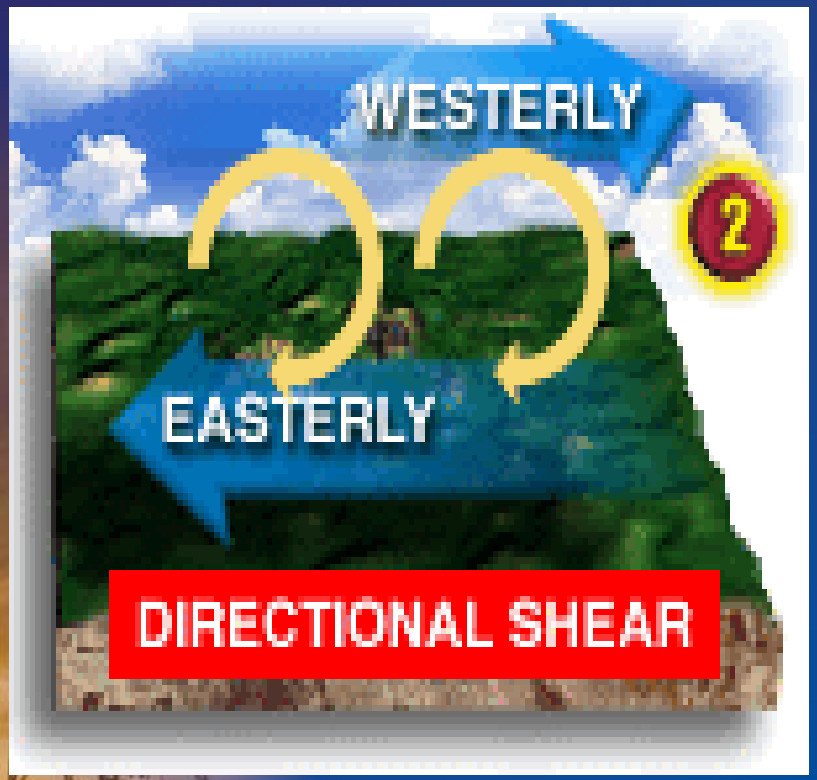


Due to favorable shear, the FFD does NOT contaminate the updraft!

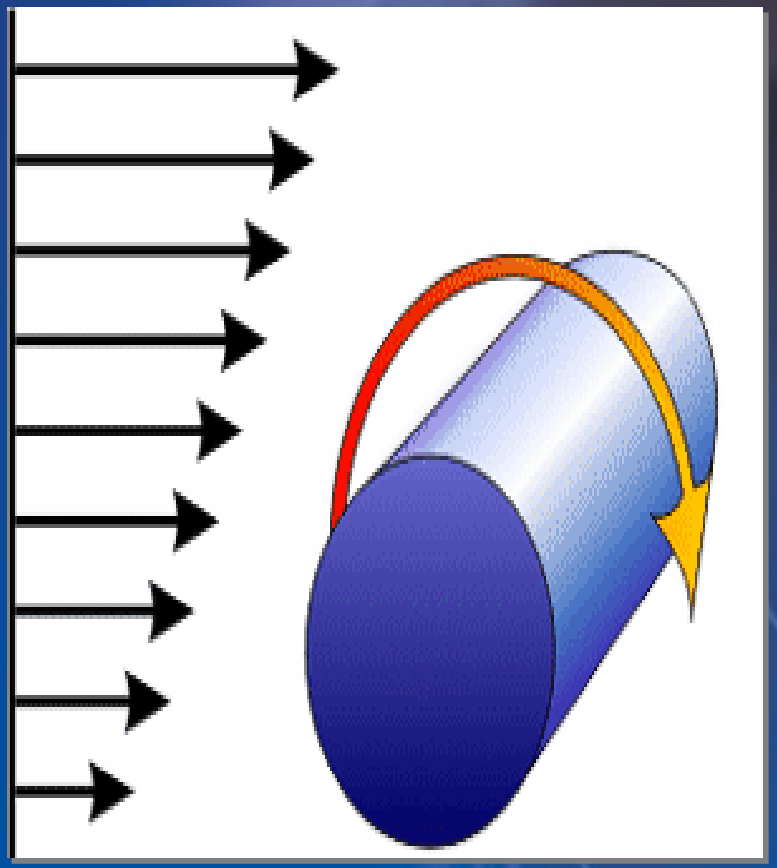
Secondary downdraft forms at rear of storm – called the Rear Flank Downdraft (RFD)

Wind Shear

Directional wind shear



Speed wind shear



Rotation in the horizontal becoming rotation in the vertical

Signs of Rotation

Spiral bands or striations in the clouds serve as a rotation indicator!

Mesocyclone

Rotating updraft within the Rain-Free Cloud Base

Present with all Supercells!

Mesocyclone

Mesocyclone gets energy from vertical wind shear concentrated in the lowest 10,000 feet of the atmosphere

Hard to see Tornado

Really Close Tornado

Hard to see Tornado

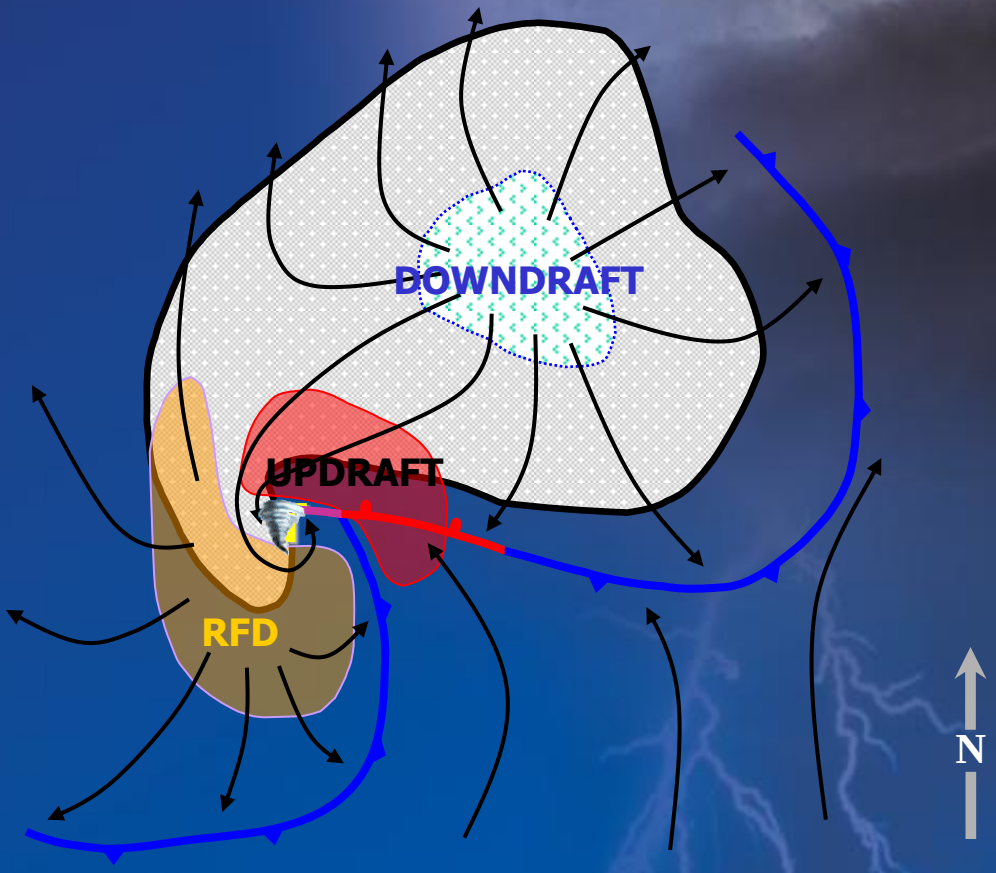
Wall Cloud – time lapse

Video

What's With the RFD?

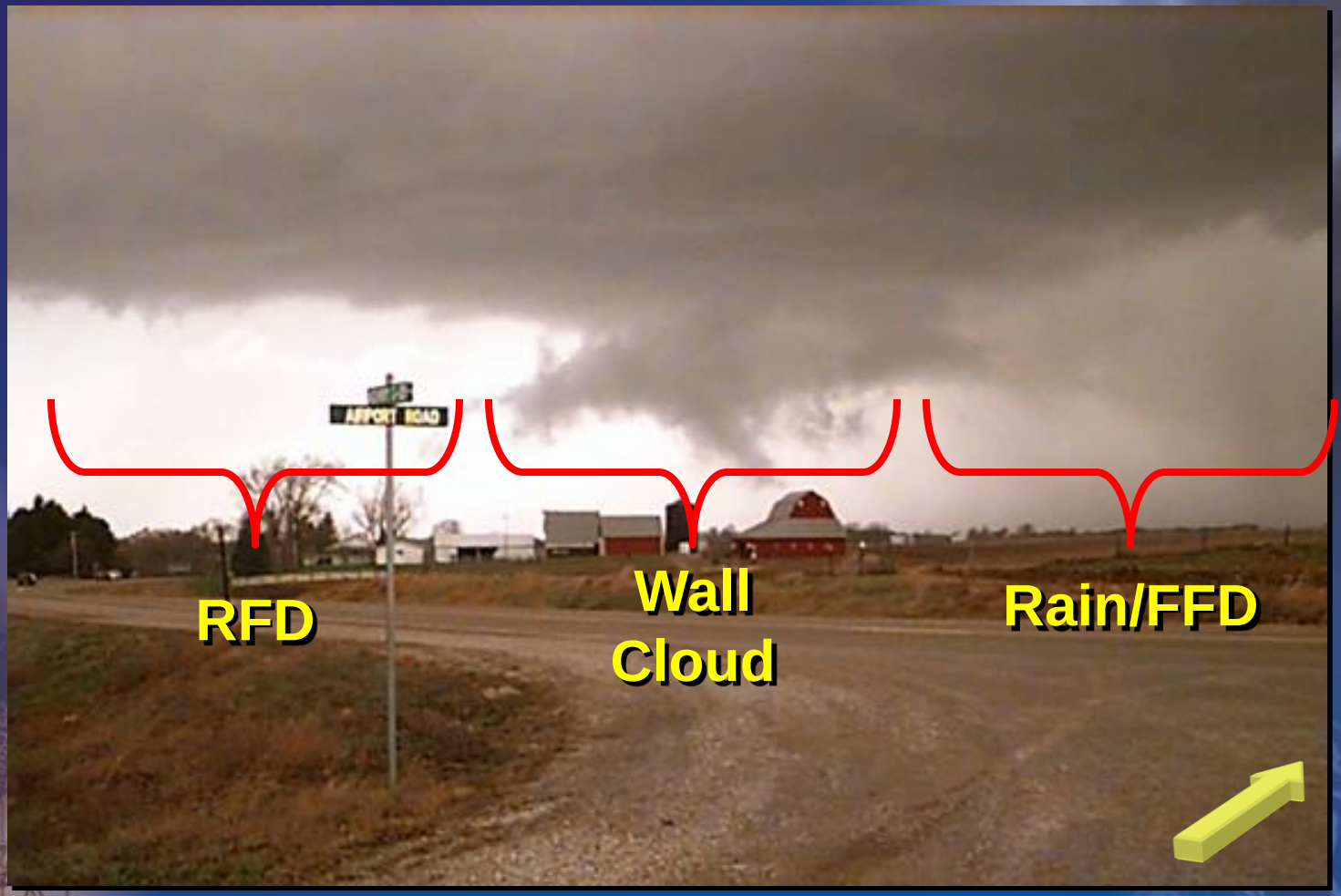
Rear Flank Downdraft

- Crucial to tornado development
- Downdraft on backside of updraft tower
- Wraps around updraft to tighten circulation



(Top view)

Rear Flank Downdraft

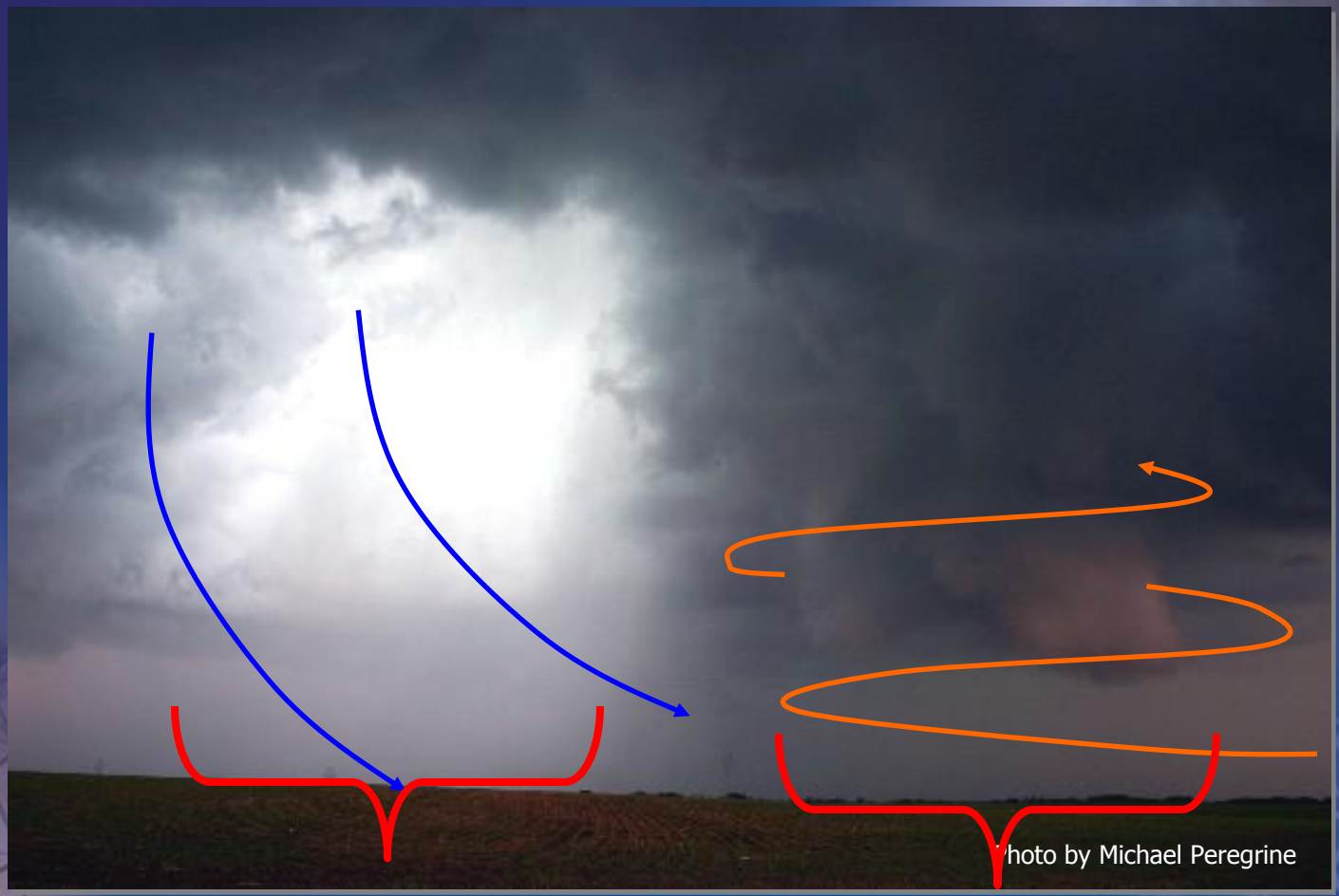


(Looking northwest)

April 11, 2001 / Pella, IA

Photo by Jim Emmert

Rear Flank Downdraft



RFD

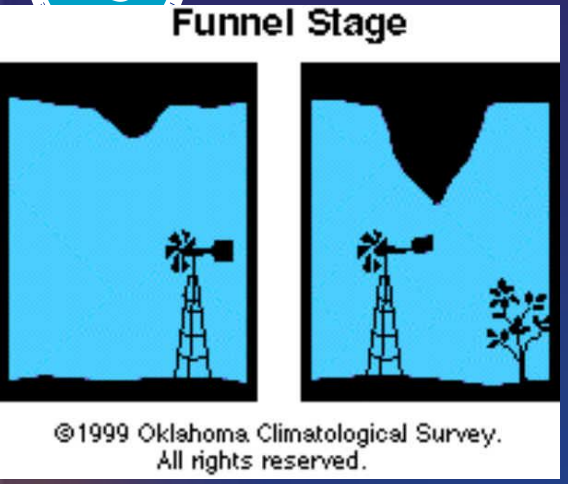
Wall Cloud

Rear Flank Downdraft

RFD Kicking up Dirt/Dust

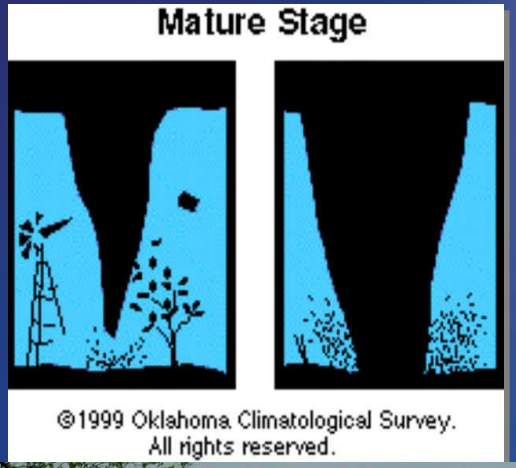
The Tornado

Tornado Life Cycle



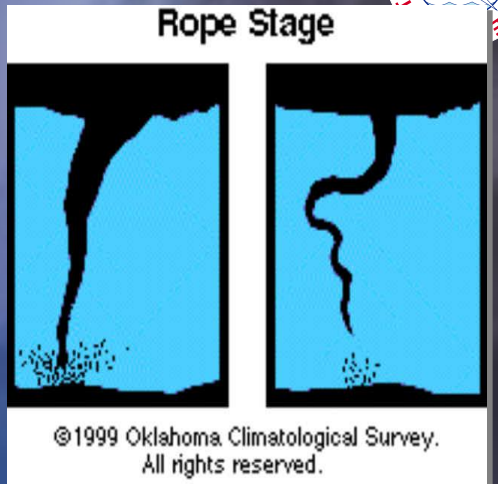
Ardmore, OK April 29, 1985 NOAA

A rotating wall cloud is evident, with tighter rotation in the base of the cloud. As the tornadic circulation continues to develop, the funnel appears.



Carter County MO F4 tornado 4/24/02 – Photo by: Mike Gossett

Mature tornadoes form in storms which continue to get a good inflow of warm, moist air, and the circulation is near the maximum size and intensity.



Perry County, IL 5/31/01

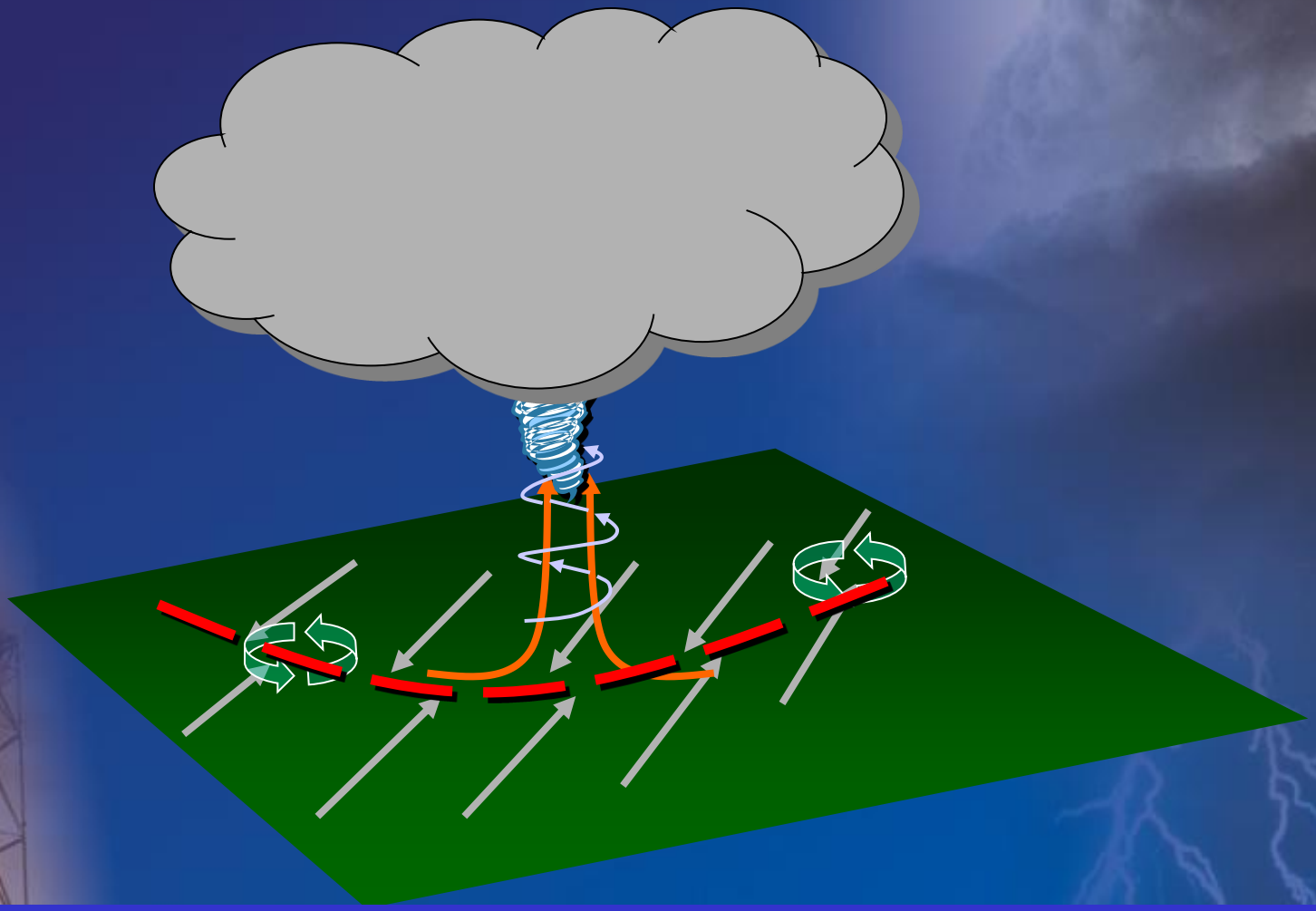
The inflow becomes disrupted a short time later, which starts the dissipating stage. The condensation funnel becomes tilted and shrinks into a contorted, rope-like configuration. The tornado is still dangerous even at this late stage in its life.

Supercell Tornado Stages

Lanspout

Tornadoes

Landspouts



Non-Supercell – usually no rotating wall cloud

Landspout Tornado

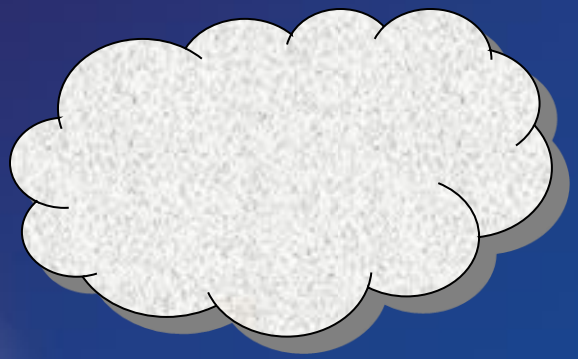
Weaker than a supercell tornado

Gustnadoes

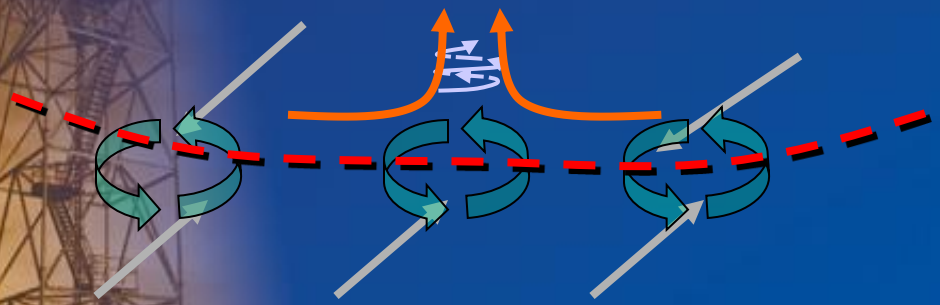
Gustnado

Weak, short-lived, ground-based ,vortex on gust front

Gustnadoes



- Aren’t tornadoes since they don’t extend to the cloud base
- Form along gust fronts
- Shallow vortices
- Report as “gustnadoes”



Funnel Clouds

Funnel Clouds

- Rotation aloft

- Report Funnel Clouds
- If funnel extends more than half way to ground, ground circulation may already exist - watch closely!

Funnel Clouds

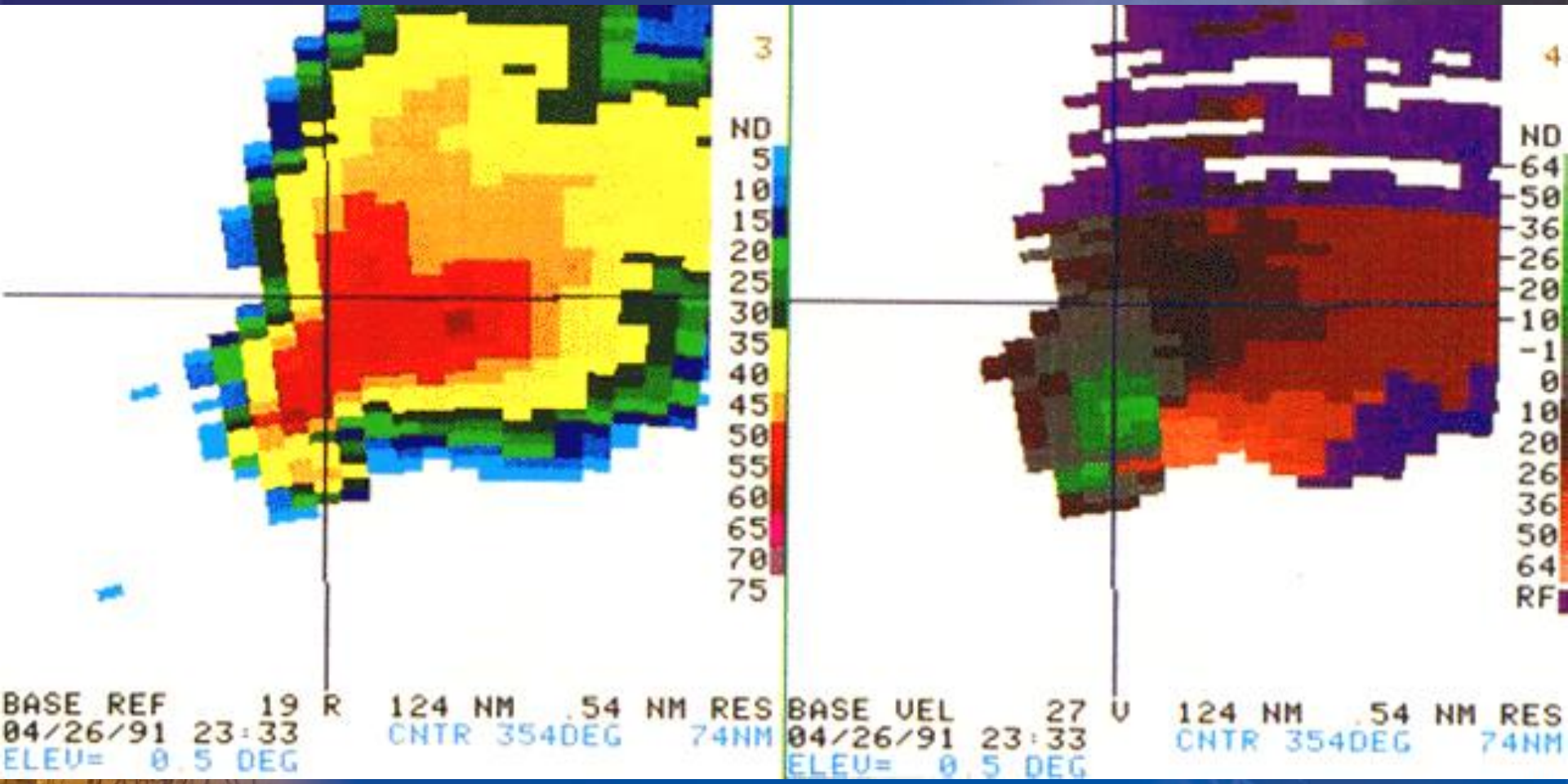
Photo by Chris Gullickson

- Some funnels can form without a Supercell
- No wall cloud - usually weaker
- Less lead time (if any); WATCH unlikely

Radar

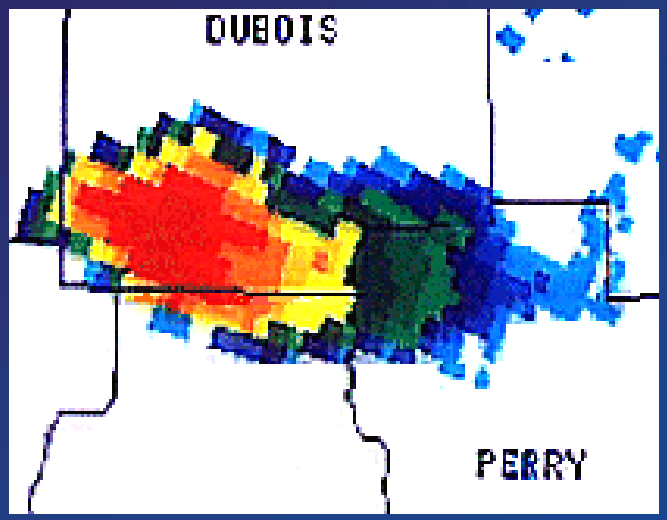
Interpretation

Classic Supercell



Storm Splitting

1



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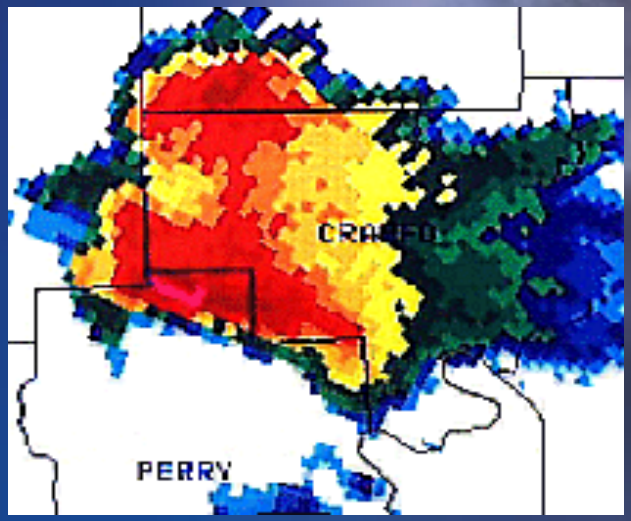

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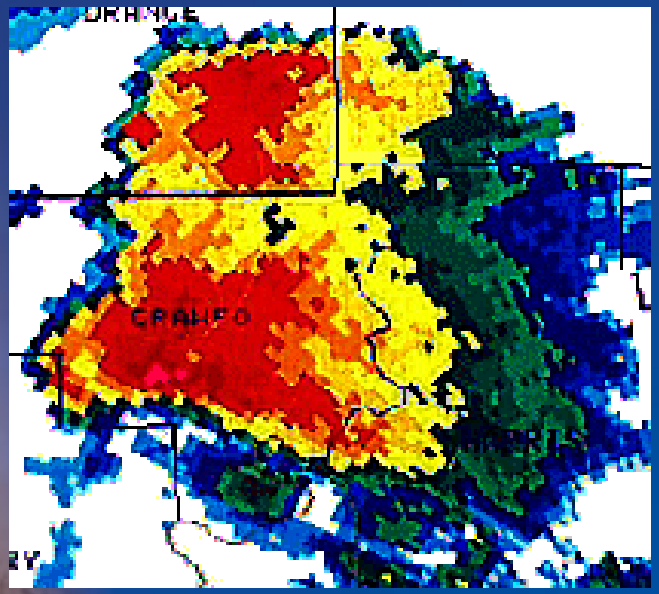

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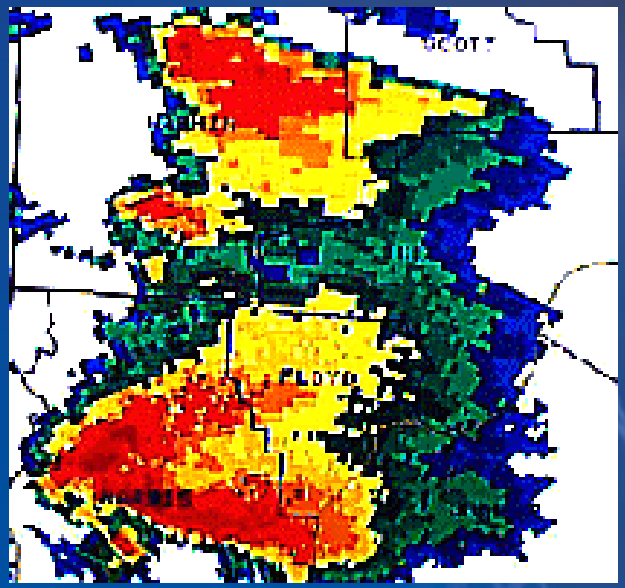
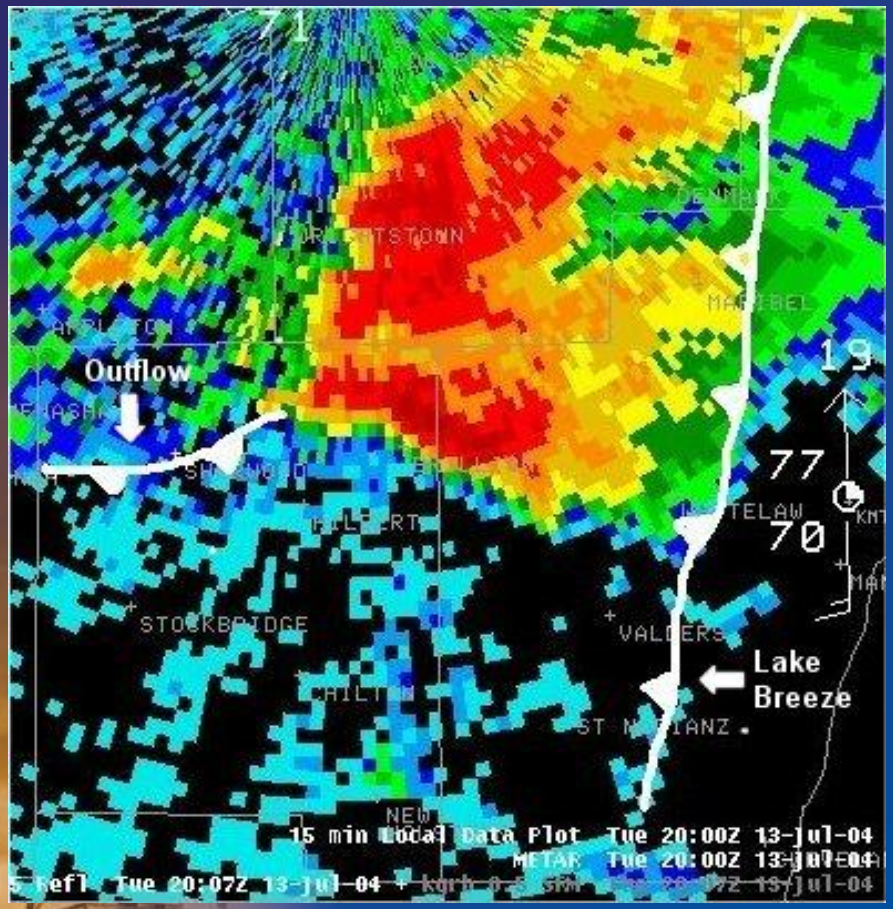
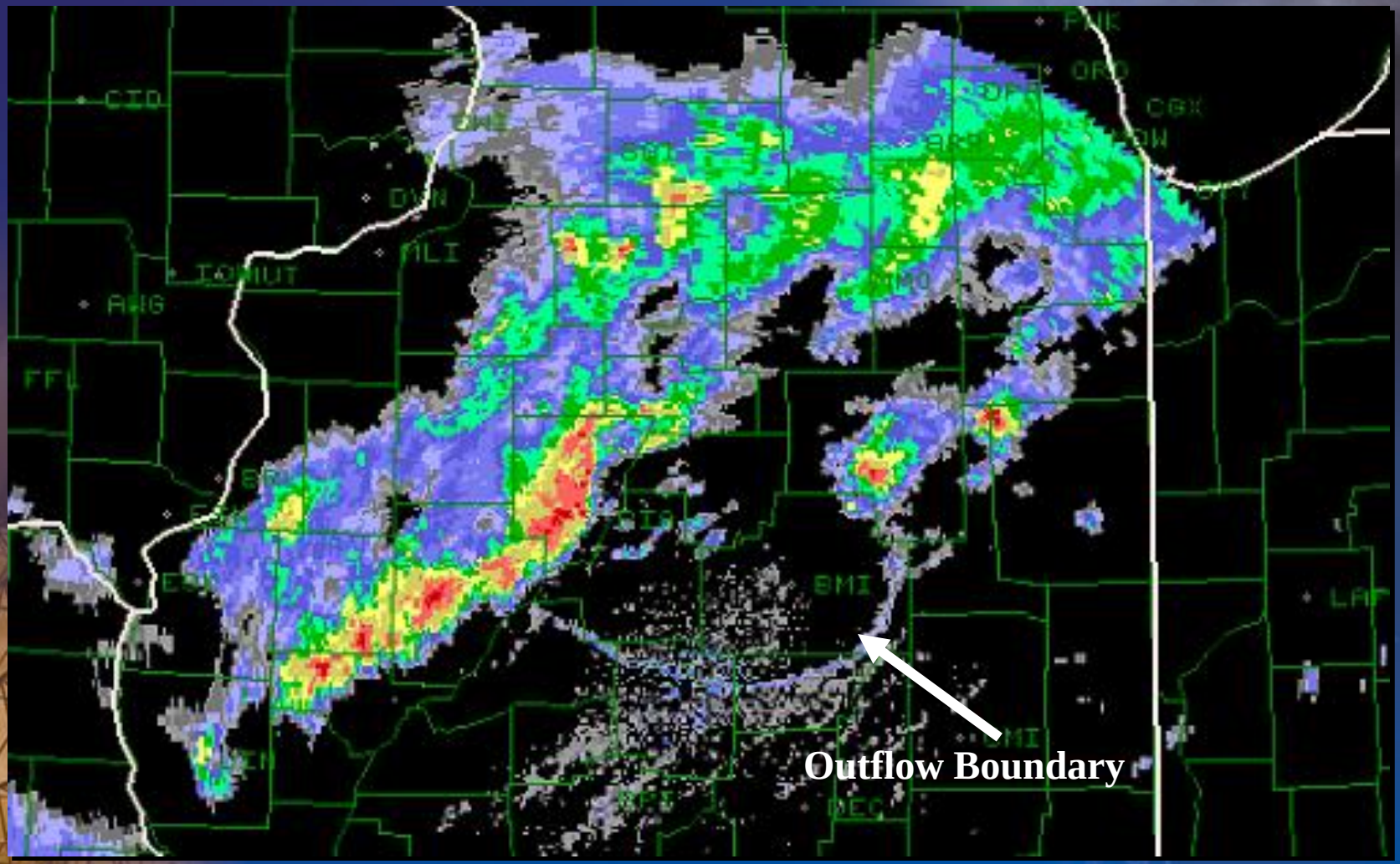


Cell Merger

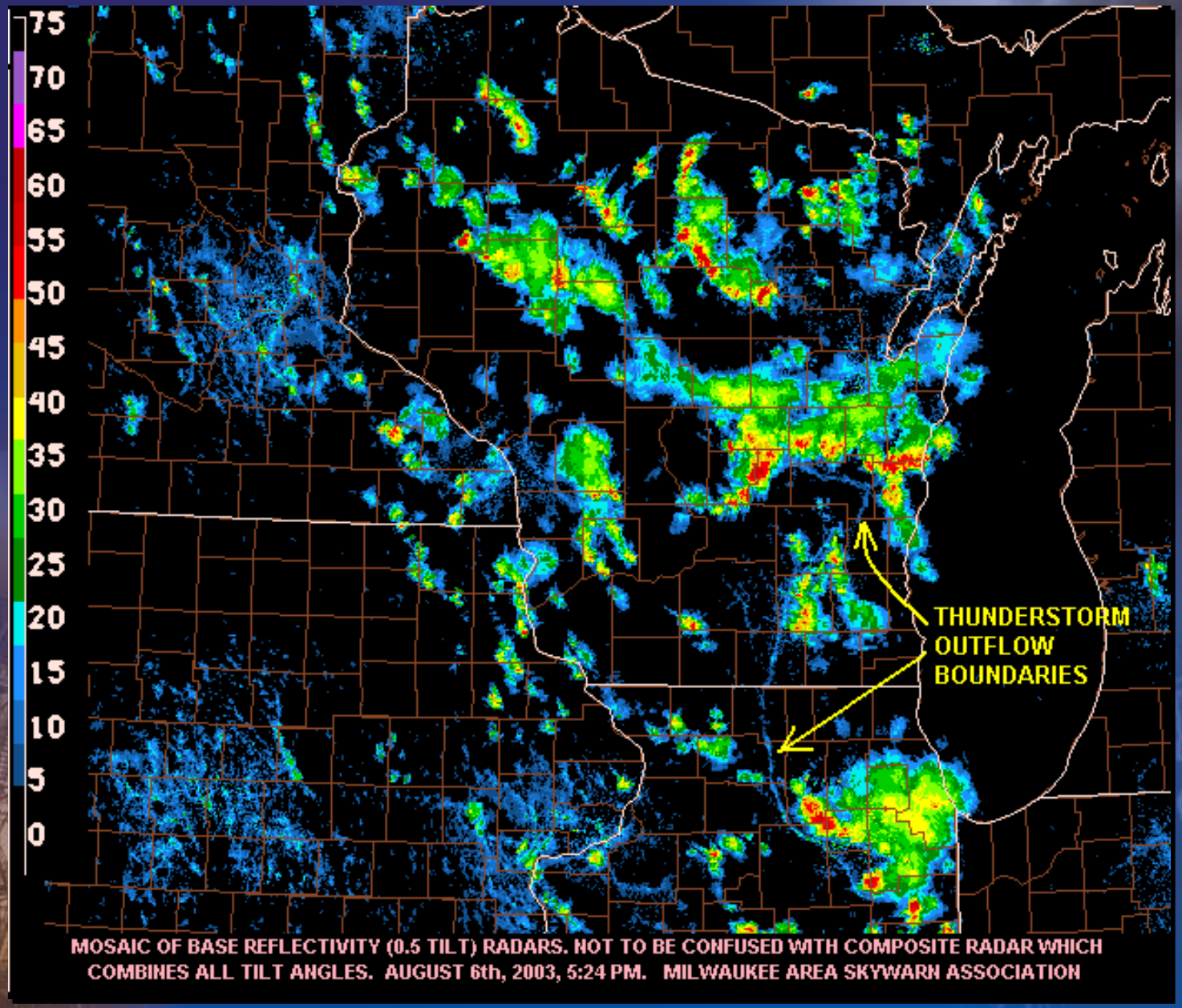

Outflow
Lake
Breeze
77
70
19
STOCKBRIDGE
VALDERS
15 min Local Data Plot Tue 20:00Z 13-Jul-04
METAR Tue 20:00Z 13-Jul-04


Outflow
Lake
Breeze
VALDERS
HILTON
NEW
HOLSTEIN
ELKHART
LAKE
15 min Local Data Plot Tue 20:30Z 13-Jul-04
METAR Tue 21:00Z 13-Jul-04
20:32Z 13-Jul-04
Tue 20:32Z 13-Jul-04

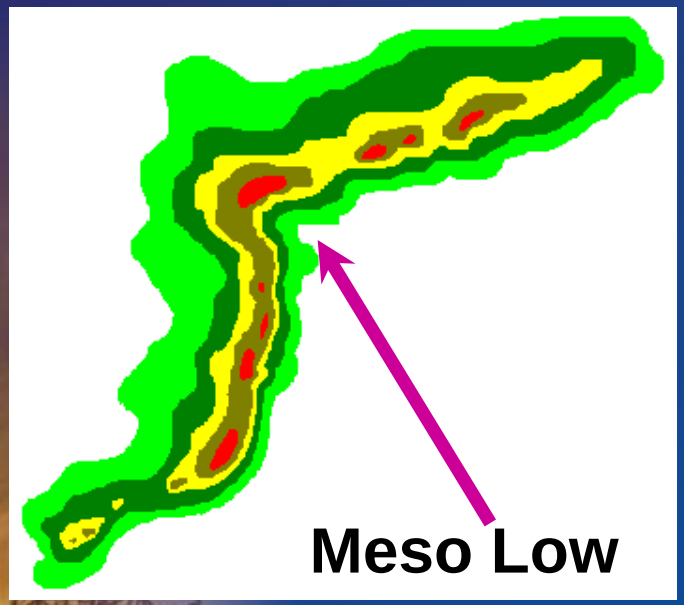
Outflow Boundaries

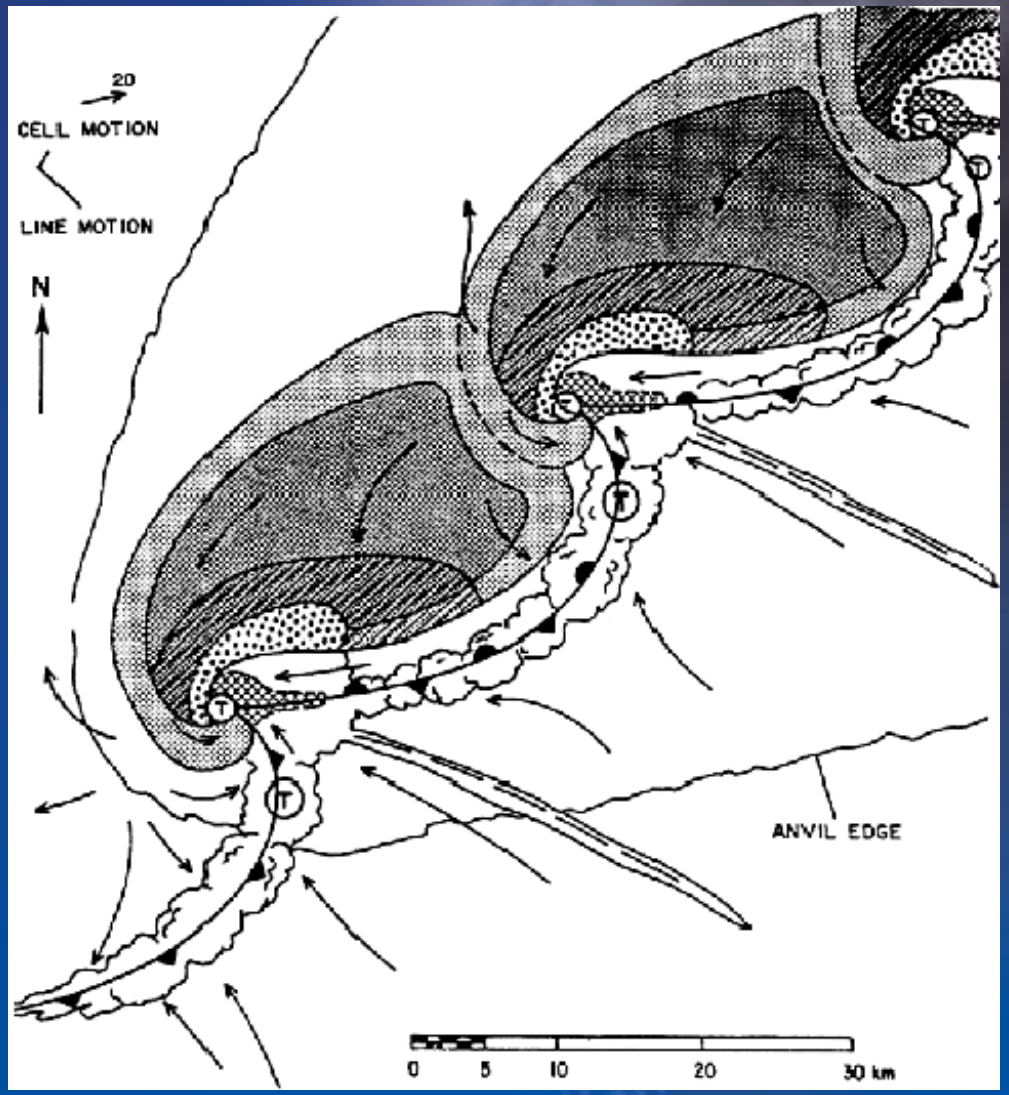


Outflow Boundaries



Line Echo Wave Pattern





Odds & Ends

Tornado or Not?

Tornado or Not?

Shelf clouds and SLCs

This SLC generated several tornado reports!

It wasn't rotating & there was no damage!

Caution

- "Better safe than sorry" means "not passing on a false tornado or funnel cloud report.
- Human weakness – adrenaline & excitement can undo months of training.
- You know enough to be dangerous – if you're not sure….don't call in your report!

Tornado or Not ??

- Quiz Time -

- Quiz Time -

Quiz time

Quiz time

Quiz Time

Outflow

- Down and away

Outflow

What is this?

What is this feature?

What about this feature?

Virga

What are these?

Rain Shafts

Tornadoes

Wall Clouds

Shelf Clouds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